Volume 39 Number 9 September 1977

Marine Fisheries REVIEW

National Oceanic and Atmospheric Administration • National Marine Fisheries Service

". . . the advantage of keeping one's nose at water level day after day . . ."
". . . the almost instant appearance of squid . . . after the night lights were switched on . . ."
"Trolling at midwater depths . . ."

Marine Fisheries Review

Vol. 39, No. 9
September 1977

CONTENTS

Articles

1 Alteration and Destruction of Estuaries Affecting Fishery Resources of the Gulf of Mexico
William N. Lindall, Jr. and *Carl H. Saloman*

8 Report of a Colloquium on the Multispecies Problem, June 1976
Edmund S. Hobson and *William H. Lenarz*

14 Innovations in Harvest of Pelagic Resources
Mitsuo Yesaki

Departments

24 NOAA/NMFS Developments

31 Foreign Fishery Developments

39 Publications

40 In Brief. . . .

Cover: The harvest of pelagic fishery resources is examined in the article beginning on page 14.

U.S. DEPARTMENT OF COMMERCE
Juanita M. Kreps, Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Richard A. Frank, Administrator

National Marine Fisheries Service
Robert W. Schoning, Director

Marine Fisheries Review is published monthly by NMFS Scientific Publications Staff, Room 450, 1107 N.E. 45th St., Seattle, WA 98105.

Publication of material from sources outside the Service is not an endorsement. The Service is not responsible for the accuracy of facts, views, or opinions of these sources.

Although the contents have not been copyrighted and may be reprinted freely, reference to source is appreciated.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director, Office of Management and Budget, through May 31, 1978.

Managing Editor: W. Hobart

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Price $1.10 (single copy). Subscription price: $12.75 a year, $15.95 a year for foreign mailing. Controlled circulation postage paid at Tacoma, Wash.

MFR PAPER 1262

Alteration and Destruction of Estuaries Affecting Fishery Resources of the Gulf of Mexico

WILLIAM N. LINDALL, Jr. and CARL H. SALOMAN

ABSTRACT–Both the commercial and recreational fishing industries of the Gulf of Mexico are overwhelmingly dependent on estuaries. About 90 percent of the commercial catch and 70 percent of the recreational catch are made up of species that are estuarine dependent. Man's alteration of estuaries is threatening these fishery resources. Data from recently published inventories of major natural and man-made estuarine features of the five gulf coastal states indicated that the total gulf estuarine area is 13,965,910 acres, including 7,890,611 acres of open-water area and 6,075,299 acres of emergent tidal vegetation. Submerged grass beds total 796,796 acres and live oyster beds amount to 158,663 acres. Major man-made alterations include 4,446 miles of federally maintained navigation channels, 138,458 acres of fill, and 795,609 acres closed to shell fishing because of pollution.

INTRODUCTION

Almost any long-term resident of, or frequent visitor to, the Gulf of Mexico can verify that not many years ago human activity was comparatively limited along the gulf coast. Even the gulf coast population is small in comparison to some coastal sections of the United States, but it is enlarging rapidly. Development associated with this population growth threatens continued production from fishery resources through destruction and alteration of aquatic and estuarine habitats.

Recognizing an accelerating competition between fish and wildlife on the one hand, and industrial and municipal growth on the other, the Gulf States Marine Fisheries Commission initiated in 1965 a cooperative inventory of the gulf estuaries to develop realistic, standardized appraisals of estuarine resources along the entire coast. Known as the Cooperative Gulf of Mexico Estuarine Inventory and Study (GMEI), the inventory included four phases—area description, hydrology, sedimentology, and biology. The area description phase of the GMEI has been completed for each of the five gulf states: Alabama (Crance, 1971), Louisiana (Perret et al., 1971), Florida (McNulty et al., 1972), Mississippi (Christmas, 1973), and Texas (Diener, 1975).

The purpose of this report is twofold: 1) to review briefly the importance of the gulf estuaries to the nation's commercial and recreational fishing industries, and 2) to provide an overview of the major natural and man-made features of gulf estuaries by summarizing information contained in the GMEI of each gulf state.

CONTRIBUTION OF GULF ESTUARIES TO THE NATION'S FISHERIES

"But while we may reasonably assume that the fisheries of the Gulf may attain much greater proportion than they now have, it is not probable that they will ever reach an importance at all comparable with such fisheries as those of New England, simply because there are not the enormous resources to draw from for a large supply of material, and also because these southern species are not likely to fill so important a place in cured food as do the staple production of northern seas."

These were the conclusions of J. W. Collins, Master of the *Albatross*, following an extensive survey of the gulf fisheries in 1885 (Thompson and Arnold, 1971). Thompson and Arnold's review of gulf fishery development over the past century, however, depicted a sharp contrast with Collins' conclusions. Since 1940, gulf fisheries have expanded greatly, and are contributing a greater proportion of the nation's catch (Fig. 1). The gulf catch rose from 250 million pounds in 1940 to 571 million pounds in 1950, and doubled again by 1960. In 1970, 1.7 billion pounds were landed. These landings represented 6 percent of the total U.S. catch in 1940, 12 percent in 1950, 26 percent in 1960, and 35 percent in 1970. The value of the catch to gulf fishermen during these three decades increased from $11 million to $166.6

William N. Lindall, Jr. is a Fishery Biologist with the Environmental Assessment Branch of the Southeast Regional Office, National Marine Fisheries Service, NOAA, 9450 Gandy Boulevard, St. Petersburg, FL 33702. Carl H. Saloman is a Fishery Biologist with the Panama City Laboratory of the Southeast Fisheries Center, National Marine Fisheries Service, NOAA, P.O. Box 4218, Panama City, FL 32401.

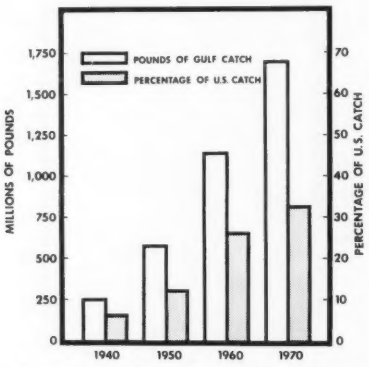


Figure 1.—Commercial fisheries catch from the Gulf of Mexico (1940-70) including the percentage of the U.S. catch.

Table 1.—U.S. commercial landings by regions, 1974[1].

Region	Thousand pounds	Thousand dollars
New England	521,565	121,843
Middle Atlantic	210,059	43,371
Chesapeake	570,297	54,275
South Atlantic	299,937	47,710
Gulf	1,772,531	240,836
Alaska	456,864	141,120
Washington and Oregon	211,515	93,481
California	745,047	130,381
Great Lakes and Mississippi River	141,322	20,025
Hawaii	10,463	5,458
Total	4,939,600	898,500

[1]Statistics on landings are shown in round weight for all items except univalve and bivalve mollusks such as clams, oysters, and scallops, which are shown in weight of meats excluding the shell. Source: Wheeland and Thompson (1975).

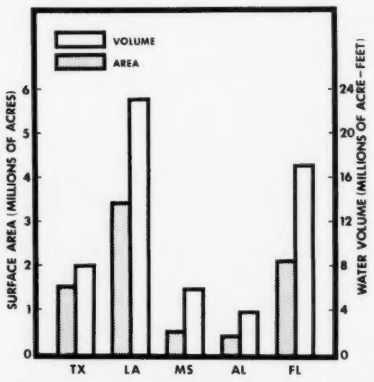


Figure 2.—Surface area (acres) and volume (acre-feet) of open estuarine waters by state.

million. Landings in 1974, the latest year for which figures are available, are shown by U.S. fishery region in Table 1. In both landings and value, the gulf was the leading region, contributing 1.77 billion pounds (36 percent of the U.S. catch) and $240.8 million (27 percent of the U.S. value).

The vast increase in quantity and value of gulf catches during the past three decades was due primarily to expansion of fisheries for shrimp, menhaden, and blue crab, and the start of a new fishery in 1952 for bottom fishes, primarily spot and croaker, for the pet food industry (Thompson and Arnold, 1971). All of these species are estuarine dependent, spending all or portions of their life cycles in estuarine waters. In fact, it is estimated that about 90 percent of the commercial catch from the gulf fisheries are estuarine-dependent species (Skud and Wilson, 1960; Thompson and Arnold, 1971).

Concurrent with the expansion of commercial fishing, a marked increase in recreational fishing has taken place. In a 15-year period (1955-70), the number of U.S. recreational fishermen more than doubled, from 4.6 million to 9.5 million (Table 2). Similarly, numbers of recreational fishermen in the Gulf of Mexico during this period more than doubled, from 1.1 million to 2.3 million, and represented about 24 percent of the U.S. fishermen. In 1970, expenditures by gulf fishermen represented 33 percent of the U.S. fishermen expenditures and more than quadrupled during the 15-year period, an increase much larger than the rest of the United States. In terms of pounds that were caught, about 30 percent of the U.S. marine recreational catch occurred in the gulf (Table 2).

Table 2.—U.S. marine recreational fisheries: number of marine fishermen, expenditures, and total finfish catch by coast, 1955, 1960, 1965, and 1970.

	Fishermen[1] (1,000)			
Year	Atlantic	Gulf of Mexico	Pacific	Total
1955	2,343	1,077	1,137	4,557
1960	3,383	1,437	1,472	6,292
1965	4,178	2,084	2,043	8,305
1970	5,010	2,272	2,178	9,460

	Expenditures ($1,000)			
Year	Atlantic	Gulf of Mexico	Pacific	Total
1955	213,653	98,209	177,077	488,939
1960	346,373	144,857	134,961	626,191
1965	331,179	176,104	292,373	799,656
1970	636,380	404,646	183,679	1,224,705

	Total finfish catch[2] (1,000 lbs.)			
Year	Atlantic	Gulf of Mexico	Pacific[3]	Total
1955[4]	—	—	—	—
1960	731,852	411,110	237,339	1,380,301
1965	836,481	375,575	262,297	1,474,353
1970	917,631	485,728	173,464	1,576,823

[1]Includes persons 12 years old or older who fished at least parts of 3 days or spent $7.50 or more on fishing during the year. Does not include persons who fished only for shellfish.
[2]Weight of fish caught, but not necessarily brought ashore, by recreational marine fishermen. These weight estimates contain errors in both sampling and response. Does not include crustaceans, mollusks, and other invertebrates. In some coastal areas, recreational marine fishermen harvest significant quantities of these animals.
[3]Does not include Hawaii.
[4]No survey in 1955.
Source: Wheeland and Thompson (1975).

Based on the knowledge of the life histories of fish that comprised the recreational catches (listed in Wheeland and Thompson, 1975), we estimated that 70 percent (by weight) of those fish taken in the gulf were estuarine dependent. Thus, both the recreational and the commercial fishing industries of the Gulf of Mexico are overwhelmingly dependent on gulf estuaries for continued production of fishery resources (Sykes and Finucane, 1966).

DIMENSIONS OF MAJOR NATURAL FEATURES

Open-Water Area and Volume

The total open-water area of estuaries calculated at mean high water is 7,890,611 acres with a volume of 57,880,568 acre-feet (Fig. 2). Louisiana contains 43 percent (3,378,924 acres) of the gulf's open estuarine waters and 40 percent (23,140,497 acre-feet) of the volume. Florida ranks second with 26 percent (2,081,525 acres) of the area and 30 percent (17,134,163 acre feet) of the volume, followed by Texas, Mississippi, and Alabama with 19 percent, 6 percent, and 5 percent of the area and 14 percent, 10 percent, and 7 percent of the volume, respectively (Fig. 2).

Thousands of acres of the gulf's open-water estuaries have been physically destroyed or altered by dredging

and filling. Chemical adulteration by domestic and industrial wastes has affected several hundred thousand more acres. The obliteration of open-water areas threatens the continued productivity of fishery resources because these areas provide nursery and forage grounds for both recreationally and commercially important species.

Emergent Vegetation

The total area of tidal marsh along the gulf coast is 6,075,299 acres. As with the area and volume of open estuarine waters, Louisiana contains most (64 percent) of the gulf's tidal marsh with more than 3.9 million acres (Fig. 3). Texas ranks second with 1.1 million acres (19 percent of gulf total), followed by Florida (15 percent), Mississippi (1 percent), and Alabama (0.5 percent).

A difference in climatic conditions and a few inches of vertical elevation of substrate greatly determine the character and composition of marsh land. Accordingly, gulf coast marshes vary from narrow bands in some areas to mile-wide expanses in others. In view of the number of recent research and review papers on the role of estuarine tidal marshes, a detailed statement of the importance of emergent vegetation to fishery production would be redundant (see de la Cruz, 1973; Gosselink et al., 1974). In essence, marsh plants provide detrital material (small decaying particles) which serves as a substrate for bacteria, fungi, and protozoa that are the vital, basic energy source of the aquatic food web. The marsh also maintains water quality by filtering upland runoff and tidal waters; it serves as spawning and nursery grounds for economically important marine fishes as well as forage fishes, shrimps, crabs, oysters, and clams, and it provides shoreline stabilization.

Despite the value of marshes to the estuarine ecosystem, thousands of acres of gulf marshland have been destroyed or altered by man-made developments. Some destruction was deliberate, as with dredging and filling to provide real estate for housing and industry (Lindall and Trent, 1975). In other cases, marshland destruction was unintentional, brought about by ignorance or disregard of the natural processes required for a marsh to survive. An example of the latter is Louisiana's average annual loss of 16.5 square miles of marsh over the past 30 years, much of which was caused by man's alteration of natural hydrologic and sedimentologic processes (Gagliano and van Beek, 1970).

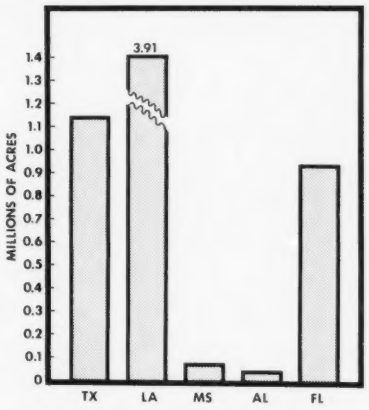


Figure 3.—Acreage of gulf tidal marshes by state. (Includes 393,160 acres of mangroves in Florida.)

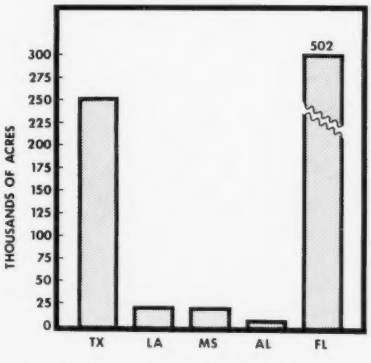


Figure 4.—Acreage of submerged estuarine vegetation in the Gulf of Mexico by state.

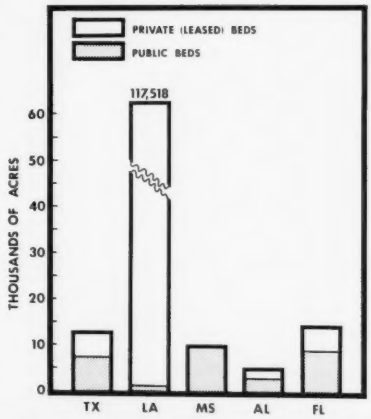


Figure 5.—Acreage of the gulf's commercially productive oyster beds, public and private (leased), by state.

Submerged Vegetation Exclusive of Algae

Determined primarily by water depth, turbidity, and salinity, the amount of submerged vegetation in gulf coast estuaries covers an area of 796,796 acres (Fig. 4). Distribution is continuous around the five gulf states, but relative abundance differs markedly among states. The vast majority (63 percent) of sea grasses occurs in Florida where relatively clear estuarine waters cover 502,431 acres. Texas estuaries, primarily the less turbid waters of Copano-Aransas Bays and Laguna Madre, rank second with 249,235 acres (31 percent of the gulf total). The turbid waters of Louisiana, Mississippi, and Alabama cover 45,000 acres, or about 6 percent of submerged vegetation in the gulf (Fig. 4).

In relation to open-water areas of the gulf estuaries, about 10 percent of the bottom is covered with sea grasses. Some 24 percent of Florida bay bottoms are vegetated, followed by Texas with 16 percent, Mississippi 4 percent, Alabama 1 percent and Louisiana 0.5 percent.

Oyster Beds

Oyster beds are present in nearly all gulf estuaries. Ranging in shape and size from small mounds to mile-long reefs, the total area of commercially productive oyster beds in gulf estuaries is 158,663 acres, including both public and private (leased) beds (Fig. 5). Louisiana has about 74 percent of the oyster beds in the five gulf states. These account for 1,200 acres of public beds and 116,318 acres of privately leased beds. Not shown are more than 450,000

acres which provide seed oysters to the Louisiana oyster industry as well as to the public (Perret et al., 1971). Florida ranks second with 13,844 acres (9 percent of the gulf total), followed by Texas, Mississippi, and Alabama with 12,477 acres, 9,786 acres, and 5,038 acres, respectively.

DIMENSIONS FOR MAJOR MAN-MADE ALTERATIONS

Dredge and Fill

Construction and maintenance of navigation channels represent the single largest form of estuarine alteration on the gulf coast. The amount of channelization by local interests (navigation districts, petroleum industries, industrial firms, county governments, municipalities, and private developers) is not known, but more than 4,400 miles of navigation channels are completed, under construction, or planned by the U.S. Army Corps of Engineers (Fig. 6). Almost all require periodic maintenance dredging.

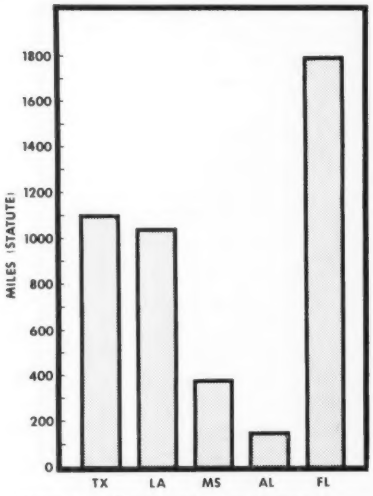


Figure 6.—Miles of navigation channels (completed, under construction, or planned) by state.

An example of the magnitude of estuarine alteration resulting from navigation channels is the amount of material that is removed annually from maintenance dredging alone. Each year, the Corps of Engineers dredges an average of 151.5 million cubic yards of sediment from gulf coast channels and harbors (Fig. 7). Put into perspective, this volume of dredged material is equivalent to a roadbed about 50 yards wide, 1 yard deep, and 1,743 miles long, the driving distance from Key West, Fla., to Brownsville, Tex. Of this annual total, 60.8 million cubic yards are dredged from Louisiana waters; 47.9 million cubic yards from Texas waters; 30.2 million cubic yards from Mississippi, Alabama, and northwestern Florida; and 12.6 million cubic yards from peninsular Florida. Some 77.7 million cubic yards, or over half, are disposed of in open water (Palermo and Montgomery, 1976).

Navigation channels are a vital part of the gulf's transportation system, but they can represent a significant threat to fishery resources through habitat destruction and alteration (Arnold, 1964). Consequences of channel dredging that are particularly damaging to fishery resources include physical loss of aquatic habitat by creation of spoil islands, segmentation and isolation of bays, increased shoaling, increased saltwater intrusion and flushing time, alteration of tidal exchange and circulation patterns, increased turbidity, and destruction of submerged and emergent vegetation (Chapman, 1968).

Filled areas, created primarily for terrestrial environments and produced by dredging adjacent water bottoms, represent the most obvious form of estuarine alteration. Some 138,458 acres of gulf estuaries are filled (Fig. 8). More than half of the five-state total occurs in Texas (78,000 acres) and is the result of spoil disposal from navigation channels (Chapman, 1968). Louisiana ranks second with 26,615 acres of fill, which, as in Texas, resulted almost totally from spoil from navigation channels. Florida ranks third with 23,521 acres of fill, but, unlike Texas and Louisiana, spoil from navigation channels accounts for less than 5 percent of the state total; the majority of Florida's fill (18,409 acres) was created for housing and industrial real estate.

Figure 7.—Disposition of dredged material generated in maintenance dredging operations and annual quantities (in millions of cubic yards) of material disposed by area by Corps of Engineers. Source: Palermo and Montgomery (1976).

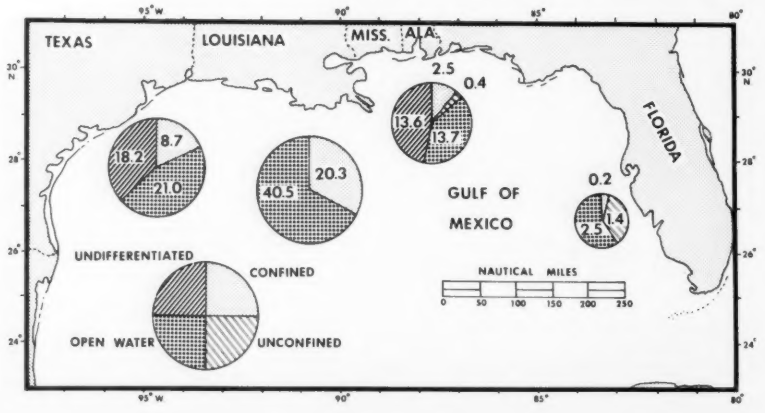
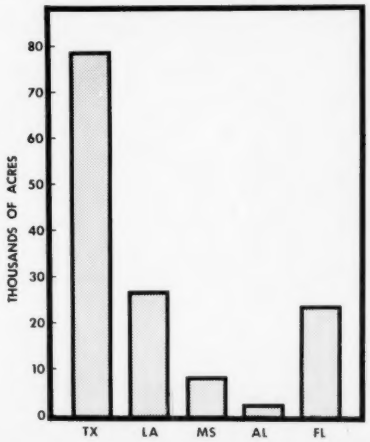


Figure 8—Acreage of fill in gulf estuaries by state. (Texas fill area taken from Chapman, 1968.)



Mississippi and Alabama estuaries contain 8,170 and 2,152 acres of fill, respectively, most resulting from spoil from navigation channels and fill for industrial development (Fig. 8).

Pollution

Few, if any, of the gulf estuaries have been spared from some form of pollution associated with the burgeoning human population in the coastal zone. An almost infinite variety of pollutants, including oxygen demanding organic materials, pesticides, petroleum products, silt, heat, radioactive substances, heavy metals, and other deleterious substances contained in sewage effluent and storm-water runoff, have chemically altered some areas to the extent that their productiveness and usefulness are endangered or lost.

It is not within the scope of this report to review the voluminous information available on pollution in the Gulf of Mexico estuaries. However, one measure of the effect of pollution on fishery resources is the amount of estuarine area closed to shellfishing. Because of various pollutants, including coliform bacteria from domestic, industrial, and agricultural sources, health authorities have closed 795,609 acres to the harvest of shellfish, especially oysters (Fig. 9). Thus, more than 1 out of very 10 acres of gulf estuaries is closed to shellfishing.

In Texas, over 40 percent of the five-state total estuarine area closure is closed to shellfishing. This accounts for 325,000 acres, or 21.2 percent of that state's estuaries. Florida ranks second

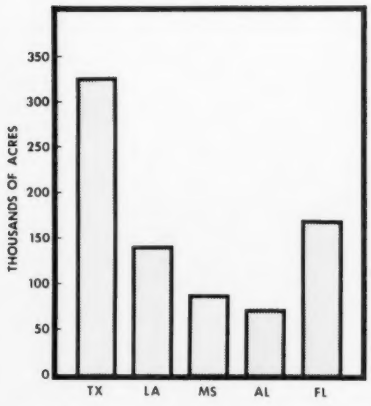


Figure 9.—Estuarine acreage closed to shellfishing by state.

Close-up view of dredge and fill operation in progress for housing and industrial development.

Completed dredge and fill project for housing development.

Marshland converted to spoil site for maintenance of navigation channels.

Table 3.—Summary of major natural features and man-made alterations of Gulf of Mexico estuaries, by state.

Feature	Texas[1]	Louisiana[2]	Mississippi[3]	Alabama[4]	Florida[5]	Gulf total
Surface area (open water), MHW[6], acres	1,532,430	3,378,924	500,379	397,353	2,081,525	7,890,611
Vegetation						
Submerged, acres	249,365	20,000	20,000	5,000	502,431	796,796
Emergent, acres	1,141,400	3,910,664	66,933	34,614	921,688	6,075,299
Total estuarine area (including open water and tidal marsh), acres	2,673,830	7,289,588	567,312	431,967	3,003,213	13,965,910
Oyster beds (live)						
Private (leased), acres	5,190	116,318	0	1,974	5,125	128,607
Public, acres	7,287	1,200	9,786	3,064	8,719	30,056
Total acres	12,477	117,518	9,786	5,038	13,844	158,663
Navigation channels, miles	1,095	1,039	374	146	1,792	4,446
Filled areas, acres	[7]78,000	26,615	8,170	2,152	23,521	138,458
Areas closed to shellfishing, acres	325,090	139,905	87,300	72,616	170,698	795,609

[1]Data from Diener (1975)
[2]Data from Perret et al. (1971).
[3]Data from Christmas (1973).
[4]Data from Crance (1971).
[5]Data from McNulty et al. (1972).
[6]MHW = mean high water.
[7]Data from Chapman (1968).

with 170,698 acres, or 8.2 percent of its estuaries. Louisiana is third with 139,095 acres (4.1 percent of its waters), followed by Mississippi with 87,300 acres (17.4 percent of its waters), and Alabama with 72,616 acres, or 18.2 percent of its waters (Fig. 9).

These figures are conservative because they do not include areas that are periodically closed when bacterial counts exceed safe levels, especially after heavy storm-water runoff. In Texas, for example, an additional 16,600 acres are periodically closed on a conditional basis.

Fortunately, not all of the oyster resources of closed areas are necessarily lost to the oyster industry (Tarver and Dugas, 1973). In Texas, for example, commercial fishermen are permitted to obtain oysters from closed areas and transport them to leased areas with acceptable water quality. After about a month of depuration (cleansing) in the clean waters, the oysters are reharvested and marketed. This process, however, results in a more costly product for the fishermen as well as the consumer.

SUMMARY AND CONCLUSIONS

Commercial and recreational fishing in the Gulf of Mexico has expanded greatly over the past three decades. Both industries are overwhelmingly dependent on gulf estuaries for the continued fishery production. Based on knowledge of the life history of species that are landed, about 90 percent (by weight) of the commercial catch and 70 percent of the recreational catch are made up of species that are dependent on estuarine habitats during all or part of their life cycles.

Presently, there are nearly 14 million estuarine acres along the gulf coast, including almost 8 million acres of open water and slightly more than 6 million acres of emergent marsh vegetation (Table 3). Within the open water area, there are more than 796,000 acres of submerged grasses and over 158,000 acres of commercially productive oyster beds.

Man's physical and chemical alterations of the gulf estuaries are threatening the continued production of its fishery resources. Major man-made alterations to date include nearly 4,500 miles of navigation channels, over 138,000 acres of fill, and closure of more than 795,000 acres to shellfishing owing to pollution (Table 3). Other alterations include clay, sand, gravel, and shell mining, marsh impoundment and drainage for mosquito control, and water control measures that alter the amount, quality, and timing of freshwater flow into the estuaries. Information on the amount of these changes is not available, but they, too, represent a threat to continued fishery production.

At first glance, the amount of manmade alteration in the gulf estuaries

seems insignificant in relation to the remaining amount of estuarine area. For example, 138,000 acres of fill represents about 2 percent of the remaining open water and about 1 percent of the total estuarine area including marsh. The significance of this loss, however, cannot be measured simply by calculating acreages. Most filling occurs in shallow bays and intertidal marshes, usually the most productive part of the estuarine ecosystem. Secondary effects are also important. For example, about 3 acres of submerged bottom are required to create 1 acre of fill (Odum, 1970). Areas from which the fill is taken are often dug to excessive depths, allowing accumulation of silt, sewage, and other pollutants which preclude the reestablishment of biota to preproject levels.

The amount of fishery resources lost as a result of man's alterations of gulf estuaries is now known. The human population along the gulf coast will continue to expand, however, with concomitant demands for domestic and industrial development in the estuarine zone. To protect fish habitat, and thus insure the continued production from fishery resources, only those projects that are essential should be permitted. Even for projects determined to be essential, their value must be balanced against permanent losses of naturally renewing resources. Presently, such losses cannot be measured accurately because of the complicated life histories of the animals that inhabit the estuaries and our lack of understanding of the more complex interrelationships between phases of their life cycles and changing physical and chemical conditions. Only through broad, basic, and detailed research and management can this knowledge be gained.

Example of marsh impoundment—prevents tidal exchange, thus nutrient exchange and the ingress and egress of estuarine-dependent organisms.

ACKNOWLEDGMENTS

We thank James E. Sykes and William S. Perret for reviewing this manuscript.

LITERATURE CITED

Arnold, E. L., Jr. 1967. Man's alteration of estuaries by dredging and filling a grave threat to marine resources. Proc. 18th Annu. Conf. Southeast Assoc. Game Fish Comm. 1964:269-273.

Chapman, C. A. 1968. Channelization and spoiling in gulf coast and South Atlantic estuaries. *In* J. D. Newsome (editor), Proceedings of the marsh and estuary management symposium, 250 p. T. J. Moran Sons Inc., Baton Rouge, La.

Christmas, J. Y. 1973. Cooperative Gulf of Mexico estuarine inventory and study, Mississippi. Phase I: Area description. Gulf Coast Res. Lab., Ocean Springs, Miss., 71 p.

Crance, J. H. 1971. Description of Alabama estuarine areas—cooperative Gulf of Mexico estuarine inventory. Ala. Mar. Res. Bull. 6, 85 p.

de la Cruz, A. L. 1973. The role of tidal marsh in the productivity of coastal waters. ASB Bull. 20(4):147-156.

Diener, R. A. 1975. Cooperative Gulf of Mexico estuarine inventory and study—Texas: Area description. U.S. Dep. Comm., NOAA Tech. Rep. NMFS CIRC-393, 129 p.

Gagliano, S. M., and J. L. von Beek. 1970. Geologic and geomorphic aspects of deltoic processes, Mississippi delta system. *In* Hydrologic and geologic studies of coastal Louisiana, p. 1-140. La. State Univ. Stud., Coastal Stud. Ser., Vol. 1.

Gosselink, J. G., E. P. Odum, and R. M. Pope. 1974. The value of the tidal marsh. Cent. Wetland Resour., La. State Univ., LSU Sea Grant Publ. LSU-SG-74-03, 30 p.

Lindall, W. N., Jr., and L. Trent. 1975. Housing development canals in the coastal zone of the Gulf of Mexico: Ecological consequences, regulations, and recommendations. Mar. Fish. Rev. 37(10):19-24.

McNulty, J. K., W. N. Lindall, Jr., and J. E. Sykes. 1972. Cooperative Gulf of Mexico estuarine inventory and study, Florida: Phase I, area description. U.S. Dep. Commer., NOAA Tech. Rep. NMFS CIRC-368, 126 p.

Odum, W. E. 1970. Insidious alteration of the estuarine environment. Trans. Am. Fish. Soc. 99:836-847.

Palermo, N. R., and R. L. Montgomery. 1976. A new concept for dredged material disposal. Misc. Pap. D-76-15. U.S. Army Engineering Waterways Experiment Station, Corps of Engineers, Vicksburg, Miss., 26 p.

Perret, W. S., B. B. Barrett, W. R. Latapie, J. F. Pollard, W. R. Mock, G. B. Adkins, W. J. Gaidry, and C. J. White. 1971. Cooperative Gulf of Mexico estuarine inventory and study, Louisiana. Phase I, area description. La. Wildlife Fish. Comm., New Orleans, 27 p.

Skud, B. E., and W. B. Wilson. 1960. Role of estuarine waters in Gulf fisheries. Trans. 25th North Am. Wildl. Nat. Resour. Conf. 25:320-326.

Sykes, J. E., and J. H. Finucane. 1966. Occurrence in Tampa Bay, Florida, of immature species dominant in Gulf of Mexico commercial fisheries. U.S. Fish Wildl. Serv., Fish. Bull. 65:369-379.

Thompson, S. H., and E. L. Arnold, Jr. 1971. Gulf of Mexico fisheries. *In* S. Shapiro (editor), Our changing fisheries, p. 200-217. U.S. Gov. Print. Off., Wash., D.C.

Traver, J. W., and R. J. Dugas. 1973. Experimental oyster transplanting in Louisiana. La. Wildl. Fish. Comm., Oyster, Water Bottoms and Seafoods Div., Tech. Bull. 7, 6 p.

Wheeland, H. A., and B. G. Thompson. 1975. Fisheries of the United States, 1974. U.S. Dep. Commer., Natl. Mar. Fish. Serv., Curr. Fish. Stat. 6700, 98 p.

MFR Paper 1262. From Marine Fisheries Review, *Vol. 39, No. 9, September 1977. Copies of this paper, in limited numbers, are available from D822, User Services Branch, Environmental Science Information Center, NOAA, Rockville, MD 20852. Copies of* Marine Fisheries Review *are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 for $1.10 each.*

MFR PAPER 1263

Report of a Colloquium on the Multispecies Fisheries Problem, June 1976

EDMUND S. HOBSON and WILLIAM H. LENARZ

INTRODUCTION

Historically, most fisheries have been managed as if populations of fishes are independent, even though many fisheries take more than one species together, often without distinguishing among them. There is concern that to manage effectively we must know how exploited populations interact with each other, with other elements of the environment, and with the fishery (and ultimately society) itself. This requires good data on each of the many species affected by the fishery, including those caught incidentally, and those seriously affected indirectly through biological relations with exploited species. Despite the general concern, however, efforts toward solution of what has been called the multispecies problem have been diffuse and uncoordinated. In fact, there is little evidence of a generally recognized broad concept, perhaps because so many variations of the problem exist.

To better define the multispecies problem, a colloquium was held at the Southwest Fisheries Center, Tiburon Laboratory, in June 1976. Under the sponsorship of the National Marine Fisheries Service, NOAA, this colloquium brought together investigators that represented a broad range of interests in fisheries biology and economics (Table 1). It was quickly recognized, however, that comprehensive solutions to multispecies problems transcend these fields to include political science, sociology, and the physical sciences. Thus, although the colloquium limited itself to topics that reflected the expertise of the attendees, it is emphasized that these topics are segments of a larger system that must be fully examined before final answers are attained.

The major components of the multispecies problem have long been recognized, but understanding their complexities has become possible only with recent advances in refined field techniques, computers, and quantitative fisheries research. Five interacting components can be identified within the system: management objectives, regulations, fleet or fishermen, exploited fish stocks, and ecosystems. The complexity of the interactions within this system, including areas within the expertise of the included research disciplines, is enormous (Fig. 1). This complexity is increased many fold by the continuously changing natures of the components. Therefore, even though the colloquium limited its attention to economics and fisheries biology, it faced a major challenge.

Table 1.—Participants in the Multispecies Colloquium.

Norman J. Abramson	National Marine Fisheries Service, NOAA, Southwest Fisheries Center, Tiburon, Calif.
Peter B. Adams	National Marine Fisheries Service, NOAA, Southwest Fisheries Center, Tiburon, Calif.
Robin Allen	Inter-American Tropical Tuna Commission, La Jolla, Calif.
William W. Fox, Jr.	National Marine Fisheries Service, NOAA, Southwest Fisheries Center, La Jolla, Calif.
Edmund S. Hobson	National Marine Fisheries Service, Southwest Fisheries Center, Tiburon, Calif.
William H. Lenarz	National Marine Fisheries Service, NOAA, Southwest Fisheries Center, Tiburon, Calif.
Loh Lee Low	National Marine Fisheries Service, NOAA, Northwest and Alaska Fisheries Center, Seattle, Wash.
Roy Mendelssohn	School of Forestry & Environmental Studies, Yale University, New Haven, Conn.
Virgil Norton	Department of Resource Economics, University of Rhode Island, Kingston, R.I.
Patric K. Tomlinson	Inter-American Tropical Tuna Commission, La Jolla, Calif.
Albert V. Tyler	Department of Fisheries & Wildlife, Oregon State University, Newport, Oreg.
Carl J. Walters	Institute of Animal Resource Ecology, University of Brirish Columbia, Vancouver, B.C.
Norman Wilimovsky	Institute of Animal Resource Ecology, University of British Columbia, Vancouver, B.C.

The colloquium concentrated on identifying the types of research that could be expected to best benefit fisheries management, and immediately recognized that sound research programs would be unlikely without stable management objectives. Because management objectives determine the information needed, and thus research plans, changes in these objectives, amplified by the many interactions among the system's components (Fig. 1), could be profoundly disruptive.

IDENTIFYING RESEARCH AREAS

Before proceeding, the colloquium examined the relations among certain

Edmund S. Hobson and William H. Lenarz are with the Southwest Fisheries Center Tiburon Laboratory, National Marine Fisheries Service, NOAA, 3150 Paradise Drive, Tiburon, CA 94920.

critical variables that characterize the diverse fisheries to be managed. A 3 × 3 matrix was constructed to do this (Fig. 2).

As illustrated by the matrix, the various fisheries can be assigned to one of the following categories: 1) a single-species fishery where only one species is taken in significant numbers, 2) a multiple-species fishery, where two or more species taken in significant number lack important interactions among them, and, 3) a multiple-species fishery where two or more species taken in significant number interact in important ways.

As further illustrated by the matrix, these fisheries can also be characterized by the types of gear used: 1) fisheries using specialized gear that takes a single species, 2) fisheries using flexible gear to take a species mix that can be altered during a given deployment, and 3) fisheries using inflexible gear to take a species mix thought to be unalterable.

It was recognized by members of the colloquium that these categories are artificial, and that the cells in the matrix are in reality points on continua. Also, it was recognized that few, if any, fisheries are characterized by any single point on the matrix. Furthermore, most fisheries can be expected to evolve under a wide range of varying pressures (economical, sociological, political, biological, and technological) that would change their positions on the matrix over time. Nevertheless, although the positions of most fisheries on the matrix are changeable rather than fixed, their characteristics at a given time center around specific points.

Further elaboration of the matrix (Fig. 3) shows the relationships among degree of management control, difficulty of determining sustainable yield, and the numbers of management options—all under the various combinations of biological and technological considerations defined above. Let us consider how the matrix might be used in planning research of management strategy. By examining the relationships shown, we can predict that a single-species fishery using specialized gear offers many management options

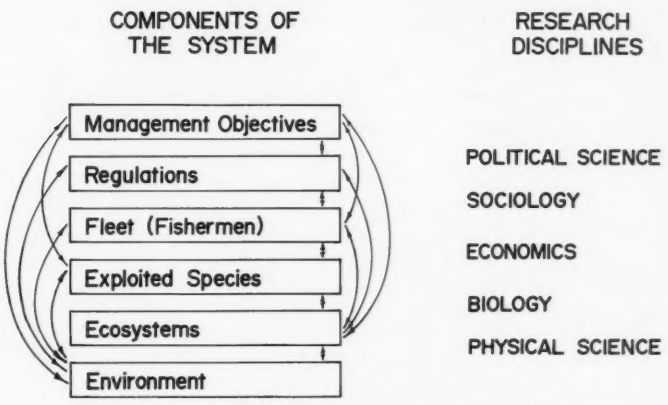


Figure 1.—Major components of the multispecies fishery problem.

FISHERY TARGET

	SINGLE SPECIES	MULTIPLE SPECIES	
		w/o interactions	w/ interactions
Specialized Gear			
Flexible Gear			
Inflexible Gear			

Figure 2.—Variables that characterize a fishery. Terms listed in the column at the left refer to the gear used.

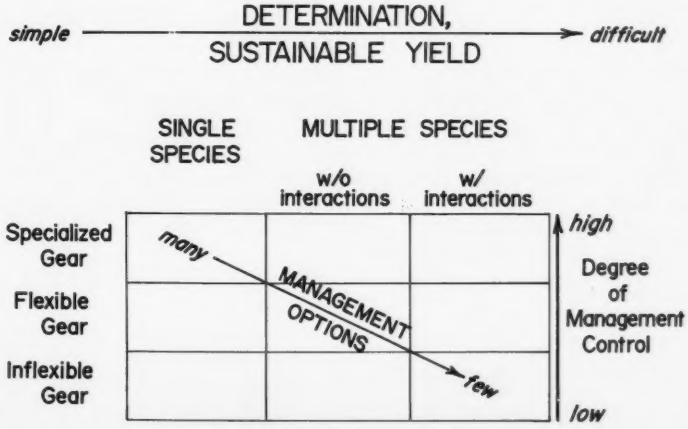


Figure 3.—Relationships among variables of a fishery.

and a high degree of management control. Under these circumstances it is relatively easy to determine sustainable yields and then implement management control if necessary—a highly desirable characteristic for management. Many fisheries, however, use what is in practice inflexible gear to take multiple species that interact significantly. Here, with few management options, and low degree of management control, the situation is unfavorable from management's point of view. Under these circumstances, management may wish to encourage more flexible fishing practices that permit greater selectivity in the catch, that is, introduce specialized methods that limit the catch to the target species. Unfortunately the fishing industry may resist these efforts through fear of increased cost or lost revenue. The histories of the International Commission for the Northwest Atlantic Fisheries and the International Pacific Halibut Commission include disputes over this issue. The fisheries involved exploit complexes of bottom and midwater fishes, and traditionally used methods and gear that took many incidental species. This resulted in dangerous stresses on species of relatively low abundance but of considerable importance to Canadian and U.S. fishermen. Some representatives of the fishery claimed the gear was inflexible, and the incidental catches unavoidable (perhaps to avoid management control). But Commission scientists, determining the gear was in fact flexible, introduced certain practices that relieved the pressures on the vulnerable species. They had, in effect, moved the position of the fishery on the matrix from row 3 to row 2 (Fig. 3), thus increasing the level of management control. Thus we see how examining the relationships illustrated by the matrix can provide insight and serve as a tool in planning research and management strategies where complex multispecies problems exist.

GENERAL NEEDS IN SOLVING MULTISPECIES PROBLEMS

Solving multispecies problems establishes research needs not unlike those that have shaped traditional single-species problems. The much greater complexities of the multispecies problems, however, require far more refined and sensitive methods and equipment. These needs can be arranged among five categories:

1) More effective data management systems.
2) More refined modeling techniques.
3) More accurate monitoring of existing fisheries.
4) More biological information on marine organisms (including species presently unexploited), with emphasis on biological interactions.
5) More emphasis on socio-economic aspects of the problem.

Elaborating on each of these, in order:

1) Historically, data collected in some fisheries programs have been underutilized because more data have been collected than even a quantitatively trained biologist can handle. Increased use of computerized data management systems and consultation with data management specialists would allow more efficient storage and retrieval of the volume of data needed to solve multispecies problems.
2) Modeling has yet to fill its anticipated role as a major tool in solving management problems. To date, computer simulation models have generally suffered from poor structure and incomplete analysis, so that much of the behavior of the models remains unknown. In particular, optimization techniques should be more widely applied to better define those characteristics of the model that the modeler wishes to emphasize. What is needed, then, is further development and more systematic application of existing techniques, as well as the development of new techniques.
3) Monitoring fisheries. Characteristics of the catch (species, age, size) of most fisheries are poorly known, particularly where a large fishery is exploited by international fleets. Without this basic information we cannot effectively apply elementary procedures to assess even single-species stocks. Obviously, then, the more complex procedures needed to solve multispecies problems cannot be implemented with data presently available. More effective monitoring of the catch is a basic need.
4) To manage our marine resources effectively we must better understand the biology of marine organisms. It is especially important to understand the important interactions among the various organisms in the ecosystem, as only then can we hope to predict what the ultimate effects of a given management decision will be.

   In defining priorities for research there has been a tendency to ignore species currently unexploited by the commercial and sport fisheries. The following considerations point to some dangers in this course:

   a) The important, often critical, biological relations of most, if not all, species valued by fishermen are poorly understood or unknown, and at least many involve species currently unfished.
   b) Among the species currently unfished are opportunities for new fisheries that would reduce pressures now concentrated on the relatively few target species.
   c) Relative values change with time, and species without commercial value today may be highly valued in the future (including many forms now taken incidentally with a target species, but discarded because of low market value).
   d) To be effective, management programs must be designed with a long-range view. A

program locked into just a few currently favored species is soon likely to become obsolete.

e) Responsibilities for managing marine resources extend beyond those species currently of direct importance to the commercial and sport fishing industries.

5) Socioeconomic problems may overshadow all other concerns of management and yet traditionally these areas have received relatively little attention. Although in many instances socioeconomic problems lie beyond the influence of management, they should be identified and anticipated in management tactics.

Where the goals of management are merely preservation of a fishery, socioeconomic concerns have little impact; however, when management objectives expand beyond preservation, as often is the case, socioeconomic considerations generally are involved, and a relatively complex system of interacting influences must be evaluated. For example, when the concern is that of a specific fishery, economic considerations may impact on the system at several levels: 1) final demand (i.e., market prices), 2) production costs, and 3) harvesting effort. It is necessary to integrate biological information with the economic considerations at each of these levels, and a major problem is to identify the type of biological information needed in each case. The above is true of a single-species fishery as well as for a multispecies fishery, but for the latter the task becomes far more complex.

SUGGESTED RESEARCH

The kinds of research needed to solve multispecies problems can be arranged in three major categories according to the time required for their completion: 1) Short-term research projects are based on existing data (a) to provide approximations or "educated guesses" that respond to immediate needs, or (b) to provide guidelines for subsequent research; 2) moderate-term research projects usually involve collecting substantial amounts of new data and last 2 to 5 years, with a clearly defined termination date from the outset; and 3) long-term research programs usually involve collecting substantial amounts of new data that will influence the ultimate course of the research; such programs have an indefinite termination date, and generally last more than 5 years.

Recognizing these major categories, the group identified meaningful research topics that probe important multispecies problems. These topics are outlined below.

Short-Term Research

Synthesis of Existing Knowledge on Diversity and Stability of Disturbed Communities

In exploiting a species, or combinations of species, there is danger of reducing the diversity within certain marine communities. Although this may or may not be an undesirable situation, the impact of such a development remains unknown. Management should know if reduced diversity might lead to instability among valuable stocks, or if its options in future management decisions are being severely limited. Although answers will require moderate or long-term research programs, a preliminary step could be the synthesizing of existing knowledge on the relation between diversity and stability in disturbed communities.

Determination of Existing Fleet Capabilities

Management must be able to estimate the pressures that a fleet can exert in response to situations that could possibly follow management decisions. This is often difficult because many uncontrollable variables, most of them economic, influence the number of vessels active at any given time. The potential of the fleet must nevertheless be estimated because management efforts that increase catch per effort are likely to increase effort.

Immediate Stock Assessment

Extended jurisdiction responsibilities have created an urgent need for approximations of existing catch and effort records. These can only be based on existing catch and effort records, the literature, and conventional analytical techniques.

Identifying Whether a Multispecies Problem Exists

With simulation modeling, a short-term effort could compare the consequence of managing several exploited species as if they were one with the results of a more complex treatment of the individual species. This should provide insight into the need for extensive research on individual species and species interactions.

Preliminary Study of Program Design

Often the course, or even the feasibility, of a long-term effort cannot be determined without a preliminary study that considers program design and other factors. These studies can be considered independent projects, and should be more widely used to reduce the possibility of commitment to fruitless long-range research.

Moderate-Term Research

Surveys

Management requires understanding, and to understand an ecosystem one must know its biological and environmental components. Two types of surveys are needed: a) comprehensive surveys without bias toward species of current economic importance, and b) surveys assessing the status of species important to the fishing industry. The former type is more complex and would take a larger effort, but both could be completed in two to three years. The conclusions that can be drawn from each of these two types of surveys are different, and this distinction must be recognized by management.

Standardization of Fishing Effort

Fisheries that exploit more than one species with flexible gear present the

need to partition effort among the species in order to estimate population abundance indices. Current methods of estimating population abundance require detailed records of catch and effort by time, area, species and mode of fishing. Data collection and/or data management systems must often be improved if this methodology is to be used.

Fleet Behavior Analysis

Behavior of fleets that use flexible gear to fish two or more species, shifting from one to another under differing circumstances, is difficult to predict, and this complicates management of the exploited species. Study of this behavior is needed. A monitoring program could compile the following data for each exploited species: catch per effort, value of catch, cost of effort, and catch limits. These data, considered with the cost of shifting from one species to another, could be analyzed with standard analytical procedures, such as linear programming. Intelligent interpretation of the results should permit predicting how the fleet is likely to react to management actions and other perturbations of the system.

Feasibility of Nonspecific Sampling

If preliminary study has indicated that it is unnecessary to consider individual species in a particular multispecies fishery (see previous section on Identifying Whether a Multispecies Problem Exists), an aggregation of species in the landings of that fishery might be sampled for age and size composition without identifying the component species. The results could then be compared with a statistical analysis of the same parameters from similar landings where the component species are separated and considered separately. From this comparison we may determine whether needed statistics can be compiled from landings where species are not separated. Possibly we can identify assemblages of species that respond as a unit to fishing pressures in a way that is consistent and repeated under measured applications of fishing effort.

Long-Term Research

Simulation Modeling

There is a need for imaginative and relatively simple models of biological communities. These must, however, incorporate a sound understanding of the biological interactions within these communities. This understanding has been lacking in the many attempts that have been made to model such communities, so it is not surprising that these attempts have failed. Although a model must be simple to have practical value in management, this does not mean the studies upon which it is based can be simple; to the contrary, simplicity in the model will come only with thorough study of the modeled situation.

Experimental Management Programs

Often it is difficult to evaluate the impact of management actions on the fishery owing to the inevitable effect of many uncontrolled variables. Consequently, it is desirable to conduct long-range experimental fishing programs that would test the effect of important management actions under controlled conditions. Among other requirements, such a program would need preserves where the experiments could be undertaken without interference from other fishing. Possible experiments include testing the impact on the populations of various modifications of fishing gear, size or catch limits, closed seasons, etc. In all such experiments, there should be sufficient time following actual manipulations of the system to monitor long-range effects.

Community Engineering

The construction of artificial reefs is one of the few areas where we have successfully influenced environmental change. Such reefs enhance sport fishing, and also permit study of disturbed communities. In addition to bettering the design of future artificial reefs, such studies will aid in predicting the impact of disturbances created by man, and also increase our understanding of natural reef communities.

Defining Communities

An important step toward meeting management goals is defining the communities of animals that include the exploited species. The concept of species assemblages (see section on Feasibility of Nonspecific Sampling) may be useful for management purposes as it may be possible to treat naturally occurring groups of animals as single species.

Stability of Ecosystems

One current theory suggests that stable ecosystems result from a particular combination of species in fixed proportions, and that such ecosystems become unstable if any one of its components is significantly disturbed. This theory should be further tested because, if true, fishing has far more impact on the ecosystem than has been assumed. Experiments with perturbed systems, such as artificial reefs and experimental management programs, could be designed with this test in mind.

Trophic Relationships

Many of the research programs suggested above indicate need to understand species interactions, and most, if not all, important interactions relate to feeding. Comprehensive understanding of trophic relationships within a community of animals is required to understand that community, and also provides valuable, often needed, background for other research.

CONCLUSION

To manage our fisheries effectively, we must develop long-range plans with stable objectives that recognize the need to understand the important interactions among resource species, other elements of the environment, the fishery, and, ultimately, society itself. To do this we need more effective data management systems and analytical techniques,more biological information, with emphasis on interspecific or intercommunity interactions, and more emphasis on socioeconomic aspects of the problem. Needed research ranges from short-term projects of fixed length, to long-term programs of indefinite length.

FUTURE MEETING

The colloquium closed with the participants unanimous in acknowledging the need for a future meeting. There was satisfaction in what had been accomplished, but recognition that it was just a beginning. Most important, it was recognized that the expressed views had been limited to those of fishery biologists and economists. The future meeting should include other viewpoints that are part of the multispecies problem, especially the views of physical scientists, political scientists, and sociologists.

REFERENCES

Dickie, L. M. 1973. Management of fisheries; ecological subsystems. Trans. Am. Fish. Soc. 102:470-480.

———. 1976. Predation, yield, and ecological efficiency in aquatic food chains. J. Fish. Res. Board Can. 33:313-316.

Hackney, P. A., and C. K. Minns. 1974. A computer model of biomass dynamics and food competition with implications for its use in fishery management. Trans. Am. Fish. Soc. 103:215-254.

Hilborn, R. 1976. Optimal exploitation of multiple stocks by a common fishery: a new methodology. J. Fish. Res. Board Can. 33:1-5.

Hobson, E. S. 1974. Feeding relationships of teleostean fishes on coral reefs in Kona, Hawaii. Fish. Bull., U.S. 72:915-1031.

Hobson, E. S., and J. R. Chess. 1976. Trophic interactions among fishes and zooplankters near shore at Santa Catalina Island, California. Fish. Bull., U.S. 74:567-598.

Larkin, P. A. 1963. Interspecific competition and exploitation. J. Fish. Res. Board Can. 20:647-678.

———. 1966. Exploitations in a type of predator-prey relationship. J. Fish. Res. Board Can. 23:349-356.

May, R. M. 1974. Stability and complexity in model ecosystems. 2d Ed. Monographs in Population Biology. Number 6. Princeton Univ. Press, Princeton, N.J., 265 p.

Parrish, J. D. 1975. Marine trophic interactions by dynamic simulation of fish species. Fish. Bull., U.S. 73:695-716.

Patten, B. C. 1969. Ecological systems analysis and fisheries science. Trans. Am. Fish. Soc. 98:570-581.

Paulik, G. J., A. S. Hourston, and P. A. Larkin. 1967. Exploitation of multiple stocks by a common fishery. J. Fish. Res. Board Can. 24:2527-2537.

Pella, J. J., and C. T. Psaropulos. 1975. Measures of tuna abundance from purse-seine operations in the eastern Pacific Ocean adjusted for fleet-wide evolution of increased fishing power, 1960-1971. Inter-Am. Trop. Tuna Comm., Bull. 16:283-400.

Regier, H. A., and H. F. Henderson. 1973. Towards a broad ecological model of fish communities and fisheries. Trans. Am. Fish. Soc. 102:56-72.

Riffenburgh, R. H. 1969. A stochastic model of interpopulation dynamics in marine ecology. J. Fish. Res. Board Can. 26:2843-2880.

Rothschild, B. J. 1967. Competition for gear in a multiple-species fishery. J. Cons. Int. Explor. Mer. 31:102-110.

Saila, S. B., and J. D. Parrish. 1972. Exploitation effects upon interspecific relationships in marine ecosystems. Fish. Bull., U.S. 70:383-393.

Silliman, R. P. 1975. Experimental exploitation of competing fish populations. Fish. Bull., U.S. 73:872-888.

Timin, M. E. 1973. A multispecies consumption model. Math. Biosci. 16:59-66.

Walters, C. J. and I. E. Efford. 1972. Systems analysis in the Marion Lake I.B.P. Project. Oecologia (Berl.) 11:33-44.

MFR Paper 1263. From Marine Fisheries Review, *Vol. 39, No. 9, September 1977. Copies of this paper, in limited numbers, are available from D822, User Services Branch, Environmental Science Information Center, NOAA, Rockville, MD 20852. Copies of* Marine Fisheries Review *are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 for $1.10 each.*

MFR PAPER 1264

Innovations in Harvest of Pelagic Resources

MITSUO YESAKI

INTRODUCTION

Alverson and Wilimovsky (1964), in describing futuristic developments in fish harvesting methods, wrote, "If man is to realize the full protein harvest from the seas, he must devise methods to utilize the great diversity of forms throughout a large geographic segment of the oceans. Many of the latent resources may not form aggregations but may be widely dispersed throughout the seas. Maximizing the harvest of the oceans thus confronts man with several alternatives: a) he must devise extremely efficient straining systems, or b) he must devise artificial methods which will cause fish to aggregate where they can be easily captured."

World fisheries production for 1973 was 65 million tons and in the future is predicted to be potentially capable of sustaining an annual catch of 100 million tons. This figure does not include increases from mariculture, nor from exploitation of unconventional resources such as krill, pelagic crabs, squid, etc. The almost twofold increase in conventional fisheries production is expected to result principally from higher exploitation in tropical and southern temperate latitudes, greater utilization of unfamiliar species, and better use of presently known and harvested resources (Robinson and Crispoldi, 1975). Rathjen (1975) noted the necessity of expanding fishing effort in the Southern Hemisphere, increasing exploitation of the ocean beyond the continental shelf, and developing new fisheries products as being essential to double the present world catch.

Mitsuo Yesaki is a Fisheries Biologist with the Regional Fisheries Survey and Development Project, P.O. Box 3225, Doha, Qatar.

Table 1.—Estimated potential harvest of underutilized species from the oceans in millions of tons (from Suda, 1973).

Oceans	Resources			
	Pelagic fish	Demersal fish	Cephalopod	Total
Northern	4.2-5.7	1.8	1.7	7.7-9.2
Southern	6.8	1.8-2.3	1.8	10.4-10.9
Tropical	10.9-17.2	11.9-14.5	2.2-3.5	25.0-35.2
Total	21.9-29.7	15.5-18.6	5.7-7.0	43.1-55.3

The potential harvest of the underutilized species from the oceans (Table 1) has been estimated by Suda (1973).

These figures show that from 25 to 31 percent of the future increases will be from pelagic species of the tropical oceans. The underutilized pelagic resources include first-stage carnivores such as flying fish and sauries and second-stage carnivores such as rainbow runners, dolphins, and small tunas.

Gulland (1971), in his general review of the fish resources of the world, assigned potential catch figures for oceanic species. His figures for the second and higher stage carnivores (other than whales, large tunas, and skipjack tuna) were as follows (in thousands of tons):

Small tunas (excluding skipjack)	Frigate mackerel	(1,000)
	Bonito	(500)
	Little tuna	?
	Thynnus tonggol	?
Sharks		(500)
Coryphaenids		1,000
Squids		10,000-100,000

There is ample evidence to suggest the most abundant species group of the open oceans is squid. In a review of the cephalopod resources of the world, Voss (1973) defined the potentially important species and estimated the potential catches of oceanic squids. These estimates were based on the probable virgin stocks of sperm whales and their likely consumption rates of squids. Potential capture figures derived from these assumptions ranged from 100 to 300 million tons and probably as high as 500 million tons.

The above-cited papers indicate the potential catch of second- and higher-stage carnivorous pelagic fish (excluding large tunas and skipjack) to be 2.5 million-plus tons and that of oceanic cephalopods to be between 10 and 500 million tons. These resources generally are sparesely dispersed throughout the

warm-temperate and tropical oceans. The basic problem in harvesting these resources is essentially one of localizing and/or concentrating individuals scattered over a wide area. Gulland (1971) stressed the necessity of technological research on catching and processing methods as well as biological research on the distribution and behavior, especially occurrences of oceanic species. Voss (1973) confessed, with regard to the oceanic squid resources, that the problem of harvesting is unsolved, but that imaginative experimentation in this field has a high chance of success.

The purpose of this review is to present the author's concepts of possible means of localizing and concentrating pelagic species for harvesting at economically feasible rates. This paper is divided into two parts: The first part presents suggestions for demonstration fishing with up-to-date equipment in areas of established fisheries and experimental fishing with modified or innovative gears and methods for unutilized species; in the second part, the author presents his concepts of the type of vessel most appropriate to carry out the proposed demonstration and experimental fishing trials.

SUGGESTED DEMONSTRATION AND EXPERIMENTAL FISHING INVESTIGATIONS

The neritic[1] and oceanic regimes are discussed separately as different fishing tactics will have to be employed in catching pelagic species from these respective areas. The fishing gears and methods currently employed in capturing neritic and oceanic species are briefly reviewed as well as pertinent information on the ecology and behavior of the species involved. This background information is given to support the various suggestions for demonstration and experimental fishing to be executed in devising means of increasing the harvest of pelagic predator resources.

Neritic Regime

Surface Multiple-Line Trolling

There are established multiple-line troll fisheries for albacore tuna, *Thunnus alalunga,* off the west coasts of North America and Europe. Vessels used in the North American fishery typically have the wheelhouse forward and clear deck aft. Two trolling poles are rigged outboard of the mast which is usually fixed immediately aft of the wheelhouse. The numbers of lines fished by these vessels range from 11 to 14 (Yoshida, 1966). Vessels in the European troll fishery usually have the wheelhouse slightly aft of midships with well deck forward and stern deck aft. Some of the European trollers are rigged with two long poles on the forward mast aft of the forecastle, whereas other vessels are fitted with two short poles on the forward mast and two longer poles on the mast aft of the wheelhouse. Vessels with four trolling poles fish as many as 19 lines (Le Gall, 1974).

Several attempts to exploit the pelagic resources of the Caribbean region by multiple-line trolling have demonstrated significant catch rates, including the results of the Jamaican Fisheries Department vessel *Bluefin* (Oswald, 1963) and the Caribbean Fishery Development Project vessels *Calamar* and *Fregata* (Yesaki[2]). The encouraging results of these vessels prompted the emphasis of trolling activities during Phase II (September 1969-August 1971) of the Caribbean Fishery Development Project. Catches varied markedly in the different areas involved during these investigations and ranged from a high of 14.0 kg/hour around the Leeward Islands to 1.2 kg/hour off the Guianas. Wagner and Wolf (1974) concluded that very little success was realized in harvesting the pelagic resources of the Caribbean with this method of fishing. Catch rates high enough to support trolling as an independent fishing means were obtained only around the banks of the Leeward Islands and this only for 2 months of the year. On the other hand, trolling was a good secondary fishing means to be employed when running to and from fishing grounds and during slack periods for other fishing methods.

Pelagic species characteristically exhibit marked fluctuations in abundance during the year. The landings of pelagic predator species can be increased during peak periods of abundance from many regions with the introduction of multiple-line trolling.

Trolling is practiced with one to three lines by artisanal fishermen off the Windward Islands in small motorized craft and off north-central Brazil in sailing vessels. Fishing trials with multiple troll lines are advocated in areas of established artisanal troll fisheries to demonstrate the practicality and greater efficiency of trolling many lines, especially during peak periods of abundance.

This method of fishing is not practiced in some parts of the world where available information indicates high indices of pelagic predator fish. High catch rates were realized by Regional Central American Fisheries Development Project vessels while incidental trolling in various areas off the Pacific Coast of Central America (Magnusson, 1971). Handline vessels fishing off the south-central coast of Brazil land over 200 tons of dolphin, *Coryphaena hippurus,* during the austral spring season (unpublished data). Fishing trials with multiple troll lines in areas of known pelagic fish concentrations are needed to demonstrate the economic viability of this method of fishing.

Subsurface Multiple-Line Trolling

Commercial trolling for tunas and related species is practiced with surface lines. Le Gurun[3] (pers. commun.) conducted simulated production trolling in the Gulf of Aden, where catches of up to

[1]Environment over the continental shelves.

[2]Yesaki, M. 1969. Troll fishing catches in the Caribbean Sea and adjacent Atlantic Ocean. Mimeogr. pap., UNDP/FAO Caribbean Fisheries Development Project, 25 p.

[3]Jean Francois Le Gurun, FAO Masterfisherman.

1,000 kg were made while surface trolling a few hours during dawn and dusk. He is of the opinion that pelagic fish move up to the surface during hours of subdued sunlight and down to midwater depths during the day. Trolling at midwater depths may be a means of increasing catches during the period of the day when the fish are down deep. Fragmentary evidence does indicate that captures may be increased by subsurface trolling. Sport fish charter boat fishermen sometimes prefer to fish whole round scad trolled below the surface (Wickham et al., 1973). Van Pel[4] conducted subsurface trolling off Tonga in the South Pacific and obtained encouraging results. He employed a diving kite with three subsurface branchlines and five surface lines. The ratio of subsurface to surface line catches was 3:1. There were no differences in bait preference between fresh mullet, salted mullet, and tuna belly strips used during these trials.

Fish are generally located by surface activity, birds, flotsam, and tidal rips when surface trolling. Alternate means have to be employed to assist in locating subsurface fish.

Echo sounders are used in fisheries principally to determine depth, nature of the bottom, and detect concentrations of fish. Auto-scanning sonars are used almost exclusively for locating fish schools in mid-water. Experimentation with these electronic fish-finding aids while subsurface trolling is suggested to assess their usefulness in locating areas where pelagic carnivorous fish are likely to aggregate (e.g., sea bottom irregularities, concentrations of forage species), and in pinpointing schools or individual fish in the water column.

Subsurface Trolling for Large Pelagic Fish

Surface trolling speeds of about 6 knots appear to be the optimum velocity for capturing tuna and related species. Commercial trolling for albacore is usually performed at average vessel speeds of 6 knots (Yoshida, 1966). Exploratory trolling by the Caribbean Fishery Development Project vessels was practiced at 6-knot speeds, which were considered adequate for tuna species but not too fast to preclude catching other species (Wagner and Wolf, 1974). Van Pel (see footnote 4) conducted trial subsurface trolling runs at 4, 5, 6, and 7 knots and reported the optimum speed to be 6 knots.

Heavy weights or large depressors are required to maintain midwater depths while subsurface trolling at 6-knot speeds. Also, strong cables and heavy-duty winches are necessary to withstand the strain imposed by drag and for setting and hauling the gear. Technological research is required to develop the equipment and system for subsurface trolling for large pelagic fish at 6-knot speeds. For subsurface trolling at these speeds, a hydrodynamically efficient depressor is probably the best device for maintaining midwater depths. A system to facilitate fishing operations would be a towline to hold the depressor on station while trolling and a mainline for attachment of branchlines. A clothesline retrieval system of the mainline would permit checking the branchlines without having to raise the depressor. Two subsurface lines could be fished, one port and another starboard, with branchlines spaced widely on the mainline to minimize tangling (Fig. 1).

Subsurface trolling with heavy gear may be especially interesting in areas of high captures of wahoo *Acanthocybium solanderi*, such as Mouchoir Bank, Morant Bank, and Decca Ridge in the northern Caribbean region (Wagner and Wolf, 1974; Yesaki, footnote 2). Fishing trials with heavy subsurface trolling gear is suggested in such areas to ascertain its effectiveness for harvesting large pelagic fish in midwater depths.

Subsurface Trolling for Small Pelagic Fish

Sightings of large schools of rainbow runner, *Elegatis bipinnulatis*, have been reported by Caribbean Fishery Development Project personnel on Navidad and Silver banks north of Hispaniola and by Le Gurun (pers. commun.) from the Gulf of Aden. The Jamaican Fisheries Department vessel *Bluefin* captured this species surface trolling at rates of 9.0 kg/hour over "Salmon Bank" in the northern Caribbean Sea (Yesaki, footnote 2). Catches of this species by surface trolling were negligible in the other bank areas investigated in the Caribbean region (Wagner and Wolf, 1974).

Surface trolling with artificial lures presently used for tunas and related species does not appear to be an efficient method for harvesting rainbow runners. Salmon troll lures and trolling methods may be more efficient for this species. Rainbow runners resemble superficially the salmon species in body form and in mouth shape and size, so much so that the common name for this species is "salmon" in Jamaica. This resemblance suggests these species inhabit similar ecological niches and have corresponding food habits. Also, the observations of Wolf (1974) regarding the capture of rainbow runners at slow trolling speed with flying fish strips lend support to the argument that trolling with salmon fishing methods may be an effective method of harvesting this species.

It is desirable to undertake investigations with salmon troll gear, especially in areas where rainbow runners are known to concentrate, to assess the effectiveness of slow-speed subsurface trolling for this species and other small pelagic fish. Suggested areas in the Caribbean region are "Salmon", Navidad, and Silver Banks, and the Central American shelf.

Fish Attraction to Moored Objects

Fishermen in various parts of the world have taken advantage of the attraction of flotsam to pelagic fish by mooring artificial structures in the sea. Materials used for rafts appear to depend primarily on the materials available; bamboo, cork (or more recently styrofoam), and palm fronds are used

[4]Van Pel, H. Undated. Deep trolling off Tonga. Mimeogr. rep. to South Pacific Commission, 3 p.

by Japanese, Maltese, and Indonesian fishermen, respectively. Dolphin is the principal target species of the Japanese and Maltese fishermen, whereas clupeoids, scombroids, and carangids are the important species captured by Indonesian fishermen.

Many aspects of the association of organisms with naturally occurring flotsam, moored surface structures, and moored midwater structures have been studied by various authors (Hunter and Mitchell, 1967, 1968; Kojima, 1967; Hunter, 1968; Wickham et al., 1973; Wickham and Russell, 1974). These studies have shown recruitment of prey species around an object soon after mooring, followed by larger prey and predator species. Essentially the same genera of predators were attracted to floating objects in the Japan Sea and eastern central Pacific Ocean. These predators included dolphins, (*Coryphaena*), tunas (*Auxis, Euthynnus, Katsuwonus, Thunnus*), and jacks (*Caranx, Elagatis, Seriola*). On the other hand, the genera of predators observed around mid-water artificial structures in the northwestern Gulf of Mexico differed considerably from the Pacific areas. Gulf of Mexico predators included dolphin (*Coryphaena*), tunas (*Euthynnus*), mackerals (*Scomberomorus*), jacks (*Caranx*), cobia (*Rachycentron*), and barracuda (*Sphyraena*).

Wickham et al. (1973) assessed the efficiency of midwater structures for attracting pelagic predators by trolling around these structures and in adjacent control areas. Troll catches (principally of little tunny, *Euthynnus alletteratus*, king mackerel, *Scomberomorus cavalla*, and dolphin) were significantly higher around single and multiple structures than in the control areas.

Several attempts were made by the Caribbean Fishery Development Project to evaluate the potential of surface artificial structures for increasing fisheries production (Wolf, 1974). These attempts were frustrated by natural loss of structures and interference from local fishermen. Hunter and Mitchell (1968) experienced similar losses and/or theft of moored floating structures, whereas such problems were not encountered by Wickham et al. (1973) with mid-water structures.

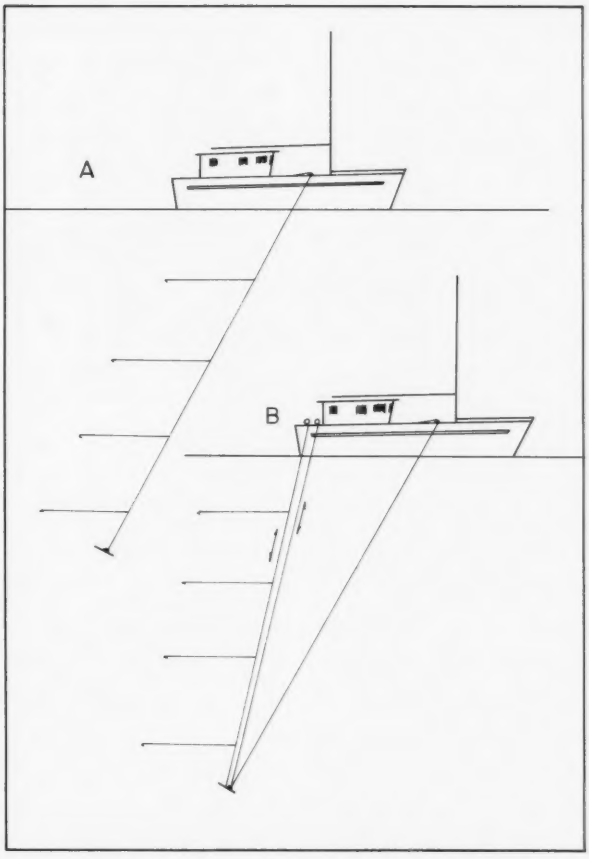


Figure 1.—Deep midwater trolling. A. Depressor (or heavy weight) on mainline with attachment of branchlines on the mainline. With this type of system, the depressor has to be raised to check the branchlines. B. Depressor on a towline to maintain fishing depth and a pulley mechanism on the depressor for attachment of a double mainline. The pulley mechanism and double mainline permit checking the branchlines without raising the depressor.

All available evidence shows moored artificial structures to be highly effective in concentrating pelagic species. Landings of pelagic predator fish can probably be increased from many areas with introduction of the use of moored structures. Introduction of this method of concentrating fish would entail experiments to determine the local materials best suited for fabricating these structures. Also, demonstration fishing would be essential to prove to local fishermen the effectiveness of moored structures in increasing catches of pelagic predator fish.

Floating Fish Pots

Fishermen in Papua New Guinea use large dirigible-shaped floating pots made of bamboo strips to catch rainbow runners (Anonymous, 1968). This pot is fished a few meters below the sea

surface and is moored in promising locations at sea out to the edge of the continental shelf.

While a consultant with the U.S. National Marine Fisheries Service based in Jamaica during early 1971, I had an opportunity to converse with a local fisherman about experimental fishing trials with floating pots. The pots used for these trials were slightly larger versions of the Z-type indigenous to the Caribbean (Wolf and Chislett, 1974). These pots were set over the edge of the continental shelf. The mooring system used to hold the pot on location consisted of a short branchline from pot to buoy and mooring line from buoy to anchor. Species reportedly captured in these floating pots included rainbow runners and white jack.

Pots are efficient fishing gears in the sense that very few man-hours are required for operation. Pots can be set and lifted in a matter of minutes. This gear is fishing the entire interval from setting to lifting without requiring further attention, during which time other fishing methods can be pursued. Research with floating pots is recommended to evaluate the relative efficiencies of different types of pots in capturing small pelagic predator fish and the commercial potential of this gear in areas where these species are known to concentrate.

Fish Attraction to Night-Lights

Night-lighting is practiced around the Caribbean Leeward Islands to capture king mackerel. This fishery is conducted at night from small boats anchored in suitable locations with an artificial light source. Pelagic forage species are soon attracted to the light, which are subsequently dipnetted and used as live bait for handlines. The live bait is allowed to take the line out with the current. King mackerel attracted either to the light or the concentrations of forage species, are captured with the handlines.

Incidental night-lighting was practiced aboard the RV *Fregata* during a cruise conducted in spring 1969 on Anguilla Bank in the northern Caribbean. After a day's fishing operation, the vessel was anchored near the northeast edge of the bank with the deck lights switched on for safety. Crew members stood watch throughout the night. To help pass the time, some of the crew members on duty dipnetted flying fish attracted to the vessel lights for use as live bait for handlines. King mackerel and blackfin tuna, *Thunnus atlanticus*, were captured at night in this manner, whereas king mackerel were not captured while surface trolling during the day in the same general area.

Night-lighting aboard the RV *Alcyon* was reasonably successful in capturing rainbow runners on the Central American shelf. This species was attracted to the deck lights while the vessel was at anchor. Rainbow runners were caught by a cast-and-pull type of operation with line and baited hook (Kawaguchi, 1974). Average catch rates of 147 kg/man/day were realized during 47 fishing days from April to June.

Artificial lights for attracting and subsequent capturing with various types of fishing gear is used primarily for forage pelagic fish and the smaller squid. The above-cited examples indicate that night-lighting also is effective in attracting some species of pelagic predators. Further investigations with night-lights is recommended to define the pelagic carnivorous species which can be attracted.

Oceanic Regime

Drifting Flotsam and Vessels

It is well known that certain species of pelagic fishes are attracted to drifting objects in the open sea. Japanese live-bait and American seine fishermen have capitalized for years on this knowledge by actively searching for and fishing around drifting objects. Hunter (1968) estimates that American fishermen caught 180,000 yellowfin, *Thunnus albacares*, and skipjack tuna, *Katsuwonus pelamis*, around floating debris during 1961 in the eastern central Pacific Ocean.

Heyerdahl (1950) observed pelagic fish from the first to the last day of the *Kon-Tiki*'s 102-day voyage across the Pacific Ocean. This balsa log raft rigged with a 4.6 by 5.6-m sail drifted from Peru to the Tuamoto Archipelago at an average speed of 1.9 knots for the duration of the passage and a maximum of 3.0 knots during a 24-hour period. Fish most frequently attracted around the raft were pilot fish, flyingfish, dolphins, sharks, triggerfish, and tunas. Underwater observations made beneath the raft revealed thick concentrations of fish up to the limits of visibility. A steady supply of flyingfish for the galley was usually found on the deck of the raft every morning, as were occasional squid. Dolphin were ever present as stragglers numbering 2-3 during some days, in groups of 5-7 during most days, and in schools of 30-40 on other days. Dolphin, shark, and tuna were readily captured with handlines baited with flyingfish and squid.

A vivid account of six people stranded aboard a rubber life raft during the first part and a 9½-foot dinghy during the latter part of a 38-day ordeal in the eastern central Pacific Ocean was given by Robertson (1973). During this passage, dolphin were recorded from the first night through the following 37 days. He described in detail the frustrating attempts to catch dolphins on a spinner lure and with a hook baited with a piece of fish. Dolphin would not take these lures so he gave up fishing and instead concentrated on gaffing as a means of capturing these fish. Robertson succeeded, after three prototypes, in fashioning a gaff strong enough and with which he was able to land several dolphins. The impression one gets from reading this adventure is that dolphin, flyingfish, and scavenger fish were quite abundant, whereas sharks were less common around the raft throughout the duration of the 38-day float. During this period, the raft had drifted over 750 miles for an average speed of approximately 0.9 knots.

Potthoff (1969) recorded the sequential attraction of organisms to the research vessel, *Discoverer*, which drifted for 2½ weeks in the central tropical Atlantic. The vessel's rate of drift varied from 1.1 to 1.7 knots throughout

this cruise. An 800-watt light was rigged on the leeward side of the vessel for night-lighting and collection of organisms by dipnetting. Prey organisms attracted to the vessel were blanket octopus during the first 4 days, flyingfish in large numbers after the second day, and lantern fish in lesser numbers for the duration of the cruise. Dolphin was the dominant predator species attracted around the vessel and increased in numbers with each passing day. It was estimated at the end of the cruise that there was one dolphin per square meter of sea surface within a wide area of the vessel. Other predators included squids and large sharks usually accompanied by rainbow runners.

Observations made aboard the *Discoverer* prompted the exploratory fishing personnel of the Caribbean Fishery Development Project to undertake a drift fishing cruise (Wolf, 1974). The objectives of this cruise were to determine if a drifting vessel could attract pelagic species in commercially significant numbers and to test various fishing gears and methods for harvesting the attracted species. On this cruise, the average drift rate of the RV *Calamar* for the 14-day cruise was 1.1 knots, with higher rates of 1.5 knots for a 24-hour period and 2.5 knots for a shorter period.

Flyingfish was the first species to be attracted to the vessel. Ocean triggerfish was very abundant and captured by dipnetting or handlining and squid was captured at night by hand-jigging. Predator species were captured from the first day of the drift to the last. The most important species, in terms of weight captured, was dolphin. An estimated 90-plus percent of the catch was dolphin, as this species appeared to remain around the vessel even after being hooked and lost. Yellowfin tuna was almost always present around the vessel and was the second most commonly captured species. Rainbow runners were abundant under the vessel, but very difficult to capture. Wahoo were seen jumping in the vicinity of the vessel; however, this species was captured only by trolling. Predator species least commonly captured were skipjack tuna, shark, and bigeye tuna, *Thunnus obesus*.

This drift cruise demonstrated that commercial pelagic predators aggregated in significant numbers around a vessel, but that these species could not adequately be harvested with the fishing gears and methods employed during this cruise. Higher catches were believed possible with greater mobility to conduct trolling, gillnetting, and longlining without disturbing the established colony.

Drift fishing has interesting possibilities for further investigations. It would be especially interesting to drift at speeds of 2.5 and 3.0 knots and possibly higher. These velocities would double and triple the distance traversed by the RV *Calamar*, with possible corresponding increases in the numbers of pelagic predators attracted to the vessel. Also, surface and subsurface trolling may be more effective at higher speeds.

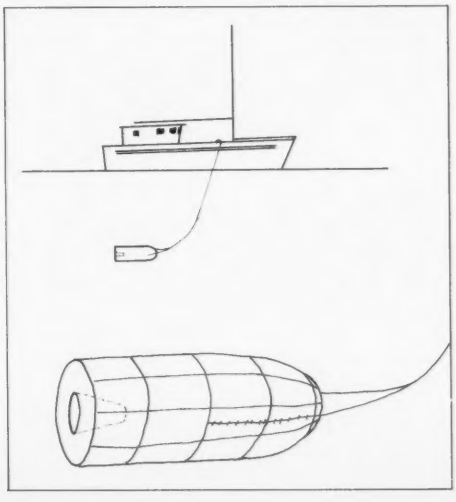
Towed Midwater Pots

Caribbean Z-type and Australian D-type pots were utilized for artificial structures to attract pelagic species and also to test their effectiveness in capturing attracted fish during the second drift cruise (Wolf, 1974). Ocean triggerfish were captured in the Z-type pots fished near the surface, but the D-type pots suspended deeper caught nothing.

A handline fishery for Caribbean red snapper is operating off the northeastern coast of South America. Some of the vessels participating in this fishery are commanded by skippers from the Canary Islands. These vessels use hemispheric pots supposedly brought from these islands. The pot has the entrance in the center of the flat end of the hemisphere. This pot is fished by drifting at 2.5 to 3.5 knots near the bottom with the entrance facing upward. The best catches reported by Fourmanoir (1968) were 100 red snappers (average size 1.5 kg) for drifts of 9-16 minutes duration in a good fishing area.

It would be interesting to experiment with modifications of the Canary Island hemispheric pot while drift fishing. An elongated, bullet-shaped pot fished with the flat end down-current may be effective for small pelagic predators and especially rainbow runners (Fig. 2). This species is captured around Papua New Guinea in pot gear and has

Figure 2.—Drifting midwater pots. Fish pots set for small carnivorous fish, such as rainbow runners, while drift fishing in the oceanic regime.



been seen concentrated under drifting vessels by Potthoff (1969) and Wolf (1974).

Drifting Artificial Structures

A second drift fishing cruise was conducted under the Caribbean Fishery Development Project to evaluate the feasibility of a series of drifting artificial structures for attracting pelagic species in commercially significant numbers and the effectiveness of monitoring and fishing around these structures at regular intervals (Wolf, 1974). This cruise was completed in two almost equal periods. Three structures spaced 2 miles apart were released during the first period, whereas six structures were released 1½ miles apart during the second period. The usual method of monitoring these structures was to troll a feather jig close around them. If a fish was captured, handlines were fished either drifting with live flyingfish for dolphin and wahoo, or slow trolling with whole flyingfish for wahoo, and flyingfish strips for rainbow runners. Tunas were taken by trolling lines with artificial lures and sharks by hand-lining with bait. Predator species, in decreasing order of attraction to the drifting artificial structures were dolphin, wahoo, sharks, usually accompanied by rainbow runners, and tunas. Flyingfish and ocean triggerfish were the first species to be attracted to the structures.

Difficulties were encountered in keeping track of the artificial structures which drifted farther apart as time passed and ultimately resulted in the loss of some of the structures. It was concluded that fish were probably attracted to these structures in greater numbers than to a drifting vessel (first drift cruise), but that the increased numbers did not compensate for the difficulties involved in keeping track of these structures.

Drifting artificial structures offer possibilities for concentrating and retaining pelagic species in the open sea. The problems of tracking and losing structures may be overcome by connecting a series of these structures in a long line along with the use of radio buoys. Radio buoys used by the tuna longline fishery are available commercially (Fig. 3). Further investigations with drifting artificial structures are required to determine their practicality.

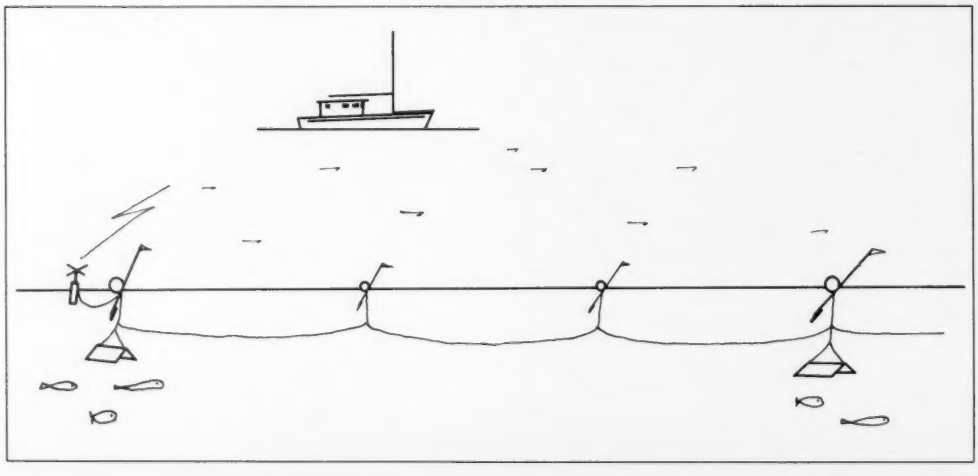
Night-Lighting

Harvey R. Bullis, Jr. (pers. commun.), in commenting on night-lighting experiences aboard the RV *Oregon* in the Gulf of Mexico and Caribbean Sea, stressed the effect of a quick switchover from a white to a red light in concentrating squids. These squids generally stay outside the periphery of white-light illumination, but a change to a red light causes the squid to aggregate in the immediate vicinity of the light source.

I participated in a squid fishing cruise conducted by the RV *Diadorin* in the southwestern Atlantic Ocean. During this cruise, three fishing stations were monitored in oceanic waters over depths exceeding 1,000 meters. At each of these stations, the 6-kilowatt lighting system was switched on after stopping the main engine. Oceanic squids appeared around the vessel a few minutes after the lights were turned on. These squid traversed the sphere of illumination singly, in groups of 2-3 individuals and in small schools (estimated to consist of 20-30 individuals). Jigging was initiated with automatic squid-jigging machines.

Ommastrephids were lured by the squid jigs and some grabbed the lures. A few ommastrephids were brought aboard, but the majority were lost due

Figure 3.—Drifting longline of artificial structures. Collapsible midwater structures strung at regular intervals on a longline to prevent the structures from drifting apart and a radio buoy to aid in localization.



to improper hooking because of small jig size and breaking of arms and tentacles because of the heavy weight of the animals. The few ommastrephids captured at the three oceanic fishing stations represented only a small fraction of the numbers observed around the vessel and the numbers lost. What impressed the author most about this experience was the almost instant appearance of squid around the vessel after the night-lights were switched on at these oceanic fishing stations.

The catch of ommastrephids by the RV *Diadorin* could have been greatly increased with larger jigs. However, slow trolling with night-lights may be a more effective method than jigging for harvesting oceanic squids. A vessel under way trolling even at slow speeds would cover a much greater area than a vessel adrift jigging, and theoretically attract a correspondingly higher number of squids.

Trolling for squid with artificial shrimp lures is practiced in the Philippines (Flores, 1974). Also, a type of trolling is conducted for cuttlefish in the Mediterranean area and for octopus in the Polynesian region (Voss, 1973). Since trolling is effective for capturing many species of cephalopods, there is no known reason why this method would not be effective for the fast-swimming oceanic squids. Slow-speed trolling with night-lights is recommended to ascertain the effectiveness of this method for capturing oceanic squids (Fig. 4a, 4b).

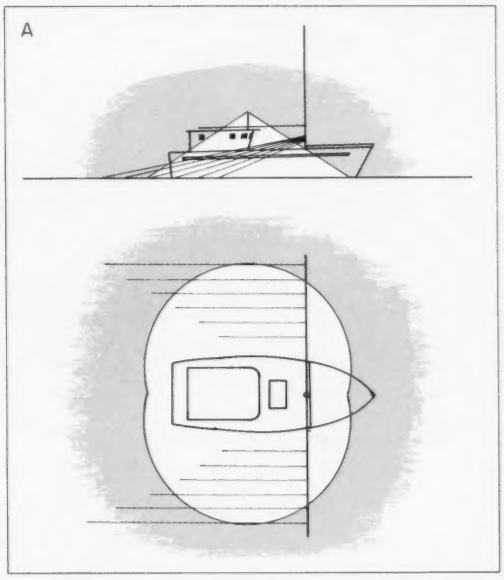


Figure 4a.—Drift trolling with night-lights. Vessel under way at low speeds with night-lights illuminated to attract oceanic squids. Multiple troll lines with squid jigs on each line.

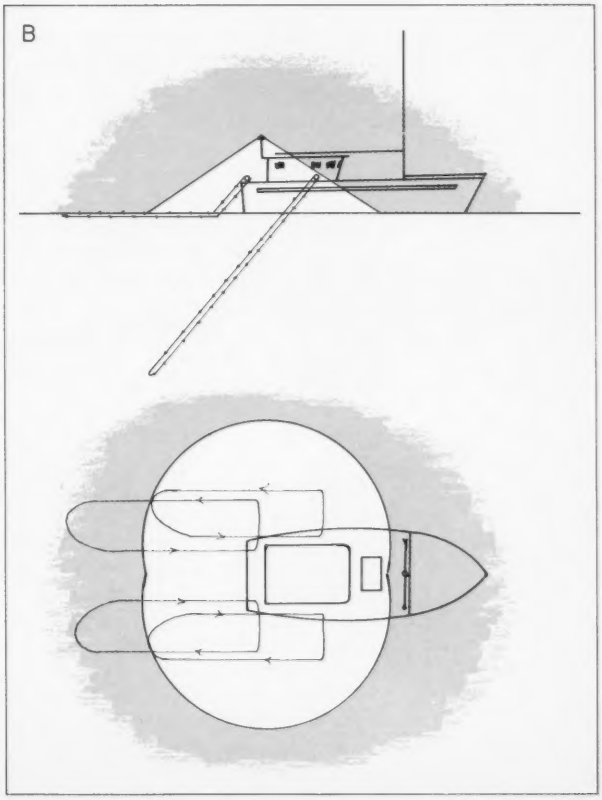


Figure 4b.—Drift trolling with night-lights. Continuous lines revolving nonstop from the vessel. Squid jigs spaced regularly on the lines with a series of plastic jigs for surface fishing and metal jigs for midwater fishing.

SUGGESTED DEMONSTRATION AND EXPERIMENTAL FISHING VESSEL

The suggested demonstration and experimental fishing investigations outlined in the foregoing section require a research vessel with capabilities for surface and subsurface trolling, handlining, night-lighting, and some pot-fishing, with trolling as the principal activity. Trollers of the North American and European albacore fisheries generally range in size from 14.0 to 21.0 meters. A vessel of 20.0 meters long is probably the optimum size for

an offshore research vessel meeting the operational requirements outlined above. Trollers can be designed with either the wheelhouse forward and clear deck aft as in North America or with well deck midships and wheelhouse aft as in Europe. The design of this research vessel will depend on consideration of requirements other than those dictated by fishing activities.

An important prerequisite of a vessel of 20.0 meters for research in offshore waters would be sea-kindliness. This vessel would have to routinely undertake cruises of about 21 days duration. A vessel design affording maximum stability and comfort to ameliorate the monotony and hardships of long trips on the open sea are of utmost importance in this instance.

This research vessel should be rigged to carry sail; to economize fuel consumption, give greater stability, and facilitate slow trolling speeds with minimum turbulence. A vessel rigged with sail for auxiliary use while steaming and fishing would reduce operating costs. There is no reason why sailpower cannot be used when conducting experimental slow subsurface trolling, drift-fishing, night-lighting/trolling, etc. Also, the rolling action of a vessel would be dampened under sail, resulting in greater stability and comfort for the persons aboard.

Sea-kindliness and rigging for sail dictate a vessel design with well deck midships and wheelhouse aft. Further particulars of this suggested research vessel are given in Table 2.

Table 2.—Design characteristics of proposed research vessel.

Dimensions	
Length, overall	20.0 m
Breadth, moulded	6.0 m
Scantling draft, moulded	2.5 m
Normal complement	
Officers/fishermen	2
Engineer/fisherman	1
Cook/fisherman	1
Fishermen	2
Scientific party	2
Total on board	8
Power, speed, endurance at sea	
Maximum continuous horsepower	180
Sea speed, sustained	8.5 knots
Cruising radius	1,000 nautical miles
Capacity for sustained operation	24+ days
Capacities	
Fish hold	15-ton capacity, iced (or refrigerated) fish
Diesel oil	10,000 liters
Fresh water	4,000 liters
Electronic navigation and fishing aids	
SSB radio	
Radio-direction finder	
Automatic pilot	
White-line echo-sounder	
Auto-scanning sonar	
Ancillary fishing equipment	
Long-line hauler	
Two, vang winches	
Two, three-spool trolling gurdies	
Two trolling poles	

DISCUSSION

The thinly scattered distribution of much of the pelagic carnivore resources of the world oceans renders these resources more amenable to exploitation by an artisanal-type rather than an industrial-type fishery. That is, catch rates of such dispersed resources are more likely to support a labor-intensive, low-investment vessel with minimum operation costs. Therefore, exploratory and demonstration fishing of oceanic species should be oriented to stimulating the artisanal fishermen of the warm-temperate and tropical regions, and more specifically those fishermen living contiguous to the eastern boundary current systems (Cushing, 1969) and the tropical insular environment (Robins, 1971). These regions are generally characterized by narrow continental shelf areas so that the oceanic regime is within a short distance. The eastern boundary current regions are especially interesting because of the upwelling in these areas and the accompanying high pelagic fish production. The tropical insular environment regions are also of interest because the pelagic carnivore resources may be the only fisheries resources of any magnitude since the restricted continental shelves in these areas negate the possibility of large stocks of demersal fish. In some instances, these demersal stocks may already be overfished, as for example, those around Jamaica (Munro et al., 1971) and also Martinique and Guadaloupe in the Caribbean region.

The experimental fishing methods suggested in this paper are simple and require a minimum of capital outlay for gear and equipment. Multiple surface trolling can be accomplished with two poles, lines, and lures; handlining with lines and hooks; night-lighting with lights, lines, and hooks; fish-potting with homemade pots of natural materials and/or wire mesh; fish-attracting with mooring lines and structures made of native materials. Ancillary line hauling equipment is available but is not mandatory for practicing subsurface trolling. Troll lines can be fished at midwater depths with weights or depressors from small vessels. The suggested fishing methods can be conducted with almost any type of powered craft in the neritic region on a day-operation basis. Larger vessels capable of extended periods at sea and equipped with electronic navigational aids and ancillary fishing equipment would be necessary to effectively exploit the oceanic regime.

A very high-expense item of fishing vessels in the future will be fuel oil. This will result in the survival of only those vessels engaged in capturing very high-unit-priced species, the most efficient vessels, or vessels capable of operating with minimum fuel consumption. An important function of an exploratory fishing and gear research vessel is to demonstrate the economic feasibility of harvesting underutilized and/or unconventional fishery resources. The pelagic predator resources are generally dispersed so sparsely throughout the world oceans that it is unlikely that these resources can be economically harvested with high-fuel-consuming vessels. A vessel rigged with sail would have reduced operating costs, thereby increasing the probability of demonstrating the economic viability of harvesting these resources.

Heyerdahl (1950) stressed the advantage of keeping one's nose at water level day after day in detecting phenomena generally overlooked while traversing the seas in large, high-speed vessels. One's nose would virtually be at water level on a 20.0-m vessel running under steadying sail. Investigations from this type of vessel may be the

key to opening the vast pelagic carnivore resources of the warm-temperate and tropical oceans for exploitation. At any rate, investigations with a 20.0-m vessel rigged with sail would be the least expensive method of assessing the fishery potential of the open seas.

Whales, deep-swimming tunas, and schooling surface-swimming tunas are the only oceanic species being exploited at present. The demonstration and experimental fishing investigations suggested in this review are urgently recommended as a first step in determining the possibility of commercially harvesting the underutilized and unconventional second-stage and higher pelagic carnivore resources of the world oceans. The results of these investigations will at best be the development of new fisheries and at worst the addition of fundamental knowledge of oceanic species.

LITERATURE CITED

Alverson, D. L., and N. J. Wilimovsky. 1964. Prospective developments in the harvesting of marine fishes. *In* Modern fishing gear of the world 2, p. 583-589. Fishing News (Books) Ltd., Lond.

Anonymous. 1968. Fish traps in Papua New Guinea. Aust. Fish. Newsl., Doc., p. 23-24.

Cushing, D. H. 1969. Upwelling and fish production. FAO Fish. Tech. Pap. 84, 4 p.

Flores, E. E. C. 1974. Studies on squids. I. A survey on Philippine traditional squid fishing grounds. Univ. Philippines, Mar. Dep. Mar. Fish. Tech. Rep., 12 p.

Fourmanoir, P. 1968. La pêche au pagre, Lutjanus aya, au large de la Guyane et du Brésil. La Peche Maritime 1080:183-186.

Gulland, J. A. (editor). 1971. The fish resources of the ocean. Fishing News (Books) Ltd., West Byfleet, Engl., 255 p.

Heyerdahl, T. 1950. The Kon-Tiki expedition. Penquin Books, 235 p.

Hunter, J. R. 1968. Fishes beneath flotsam. Sea Front. 14:280-288.

———, and C. T. Mitchell. 1967. Association of fishes with flotsam in the offshore waters of Central America. Fish. Bull., U.S. 66:13-29.

———, and ———. 1968. Field experiments on the attraction of pelagic fish to floating objects. J. Cons. Perm. Int. Explor. Mer 31:427-434.

Kawaguchi, K. 1974. Handline and longline fishing exploration for snapper and related species in the Caribbean and adjacent waters. Mar. Fish. Rev. 36(9):8-31.

Kojima, S. 1967. Studies on fishing conditions of the dolphin, *Coryphaena hippurus*, in the western regions of the Sea of Japan—XIII. 'Tsukegi' as a source of food for dolphins. Bull. Jap. Soc. Sci. Fish. 33:320-324.

Le Gall, J. Y. 1974. Exposé synoptique des données biologiques sur le germon *Thunnus alalunga* de l'océan atlantique. Synopsis FAO sur les peches, No. 109, 70 p.

Magnusson, J. 1971. Pacific coast pelagic survey off Central America and Panama Bay, June 1970 - January 1971. Projecto Regional de Desarroll. Pesquero on Centro America - Bol. Tec., Vol. IV, No. 6, 32 p.

Munro, J. L., P. H. Reeson, and V. C. Gaut. 1971. Dynamic factors effecting the performance of the Antillean fish trap. Gulf Caribb. Fish. Inst., Proc. 23rd Annu. Sess., p. 184-194.

Oswald, E. O. 1963. Developing an offshore fishery in Jamaica. Gulf Caribb. Fish. Inst., Proc. 15th Annu. Sess., p. 134-139.

Potthoff, T. 1969. Searching for tuna. Commer. Fish. Rev. 31(7):35-37.

Rathjen, W. F. 1975. Unconventional harvest. Oceanus 18:36-37.

Robertson, D. 1973. Survive the savage sea. Praeger, N.Y., 269 p.

Robins, C. R. 1971. Distributional patterns of fishes from coastal and shelf waters of the tropical western Atlantic. Symposium on Investigations and Resources of the Caribbean Sea and Adjacent Regions. FAO Fish. Rep. 71:249-255.

Robinson, M. A., and A. Crispoldi. 1975. Trends in world fisheries. Oceanus 18:23-29.

Suda, A. 1973. Development of fisheries for non-conventional species. Technical Conference on Fishery Management and Development. Vancouver, Canada, 13-23 February 1973, 55 p.

Voss, G. L. 1973. Cephalopod resources of the world. FAO Fish. Circ. 149, 75 p.

Wagner, D. P., and R. S. Wolf. 1974. Results of troll fishing explorations in the Caribbean. Mar. Fish. Rev. 36(9):35-43.

Wickham, D. A., and G. M. Russell. 1974. An evaluation of mid-water artificial structures for attracting coast pelagic fishes. Fish. Bull., U.S. 72:181-191.

Wickham, D. A., J. W. Watson, Jr., and L. H. Ogren. 1973. The efficacy of midwater artificial structures for attracting pelagic sport fish. Trans. Am. Fish. Soc. 102:563-572.

Wolf, R. S. 1974. Minor miscellaneous exploratory/experimental fishing activities in the Caribbean and adjacent waters. Mar. Fish. Rev. 36(9):78-87.

Wolf, R. S., and G. R. Chislett. 1974. Trap fishing explorations for snapper and related species in the Caribbean and adjacent waters. Mar. Fish. Rev. 36(9):49-61.

Yoshida, H. O. 1966. Tuna fishing vessels, gear, and techniques in the Pacific Ocean. *In* T. A. Manar (editor), Proceedings of the Governor's Conference on Central Pacific Fishery Resources, Honolulu-Hilo, February 28-March 12, 1966, p. 67-89. State of Hawaii, Honolulu.

MFR Paper 1264. From Marine Fisheries Review, *Vol. 39, No. 9, September 1977. Copies of this paper, in limited numbers, are available from D822, User Services Branch, Environmental Science Information Center, NOAA, Rockville, MD 20852. Copies of* Marine Fisheries Review *are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 for $1.10 each.*

NOAA Aquaculture Plan Forsees Increased World Seafood Demand, Possible Shortage

Although worldwide output from aquaculture has about doubled in the last 5 years to some 6 million metric tons, a shortage in the global supply of seafood can be expected in 10 years, according to a report just published by the National Oceanic and Atmospheric Administration, a Commerce Department agency.

Edited by John B. Glude, NOAA Aquaculture Program Coordinator, the plan describes the increasing world demand for seafoods, notwithstanding current landings exceeding 64 million metric tons, and an estimated maximum harvest of 100-150 million metric tons.

Roughly 10 percent of world fisheries production comes from aquaculture. In the United States, public aquaculture of salmon and private culture of oysters, catfish, trout, shrimp, clams, and other species yield about 65,000 metric tons, about 3 percent of landings, or 2 percent consumption of fishery products.

The potential is good for increasing fisheries production in the United States, the report states, by expanding public hatcheries, and by encouraging private farming of fish and shellfish. However, a national policy is needed to recognize that the development of aquaculture is in the national interest, and to call for the protection of coastal and estuarine environments so that aquatic foods can be produced in these areas.

The plan includes state-of-the-art summaries of the culture of high priority species, such as salmon, marine shrimp, freshwater prawn, American lobster, oysters, and marine plants; medium priority species including clams, catfish, abalone, scallop, and yellow perch; and low priority species, such as mussels, crab, and various marine fishes. Most of the expanded program would be conducted by joint efforts with individuals, firms, educational institutions, or State agencies.

Copies of the NOAA Aquaculture Plan, published as a NOAA Special Report, May 1977, are for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

Fishery Product Consumption Rose in 1976

Led by a 10 percent increase in fresh and frozen fish consumption, per capita consumption of fishery products increased to 12.9 pounds in 1976, from 12.2 the previous year, according to the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS), a Commerce Department agency. Rising individual income and increased sales in the food service sector during 1976 were prime factors in the 6 percent overall improvement in the finfish market, notwithstanding price hikes during the year.

Expanded fishery zones declared by the major fishing nations may tighten the supplies of groundfish blocks and fillets. Moreover, strong competition overseas for groundfish products may draw imports away from the United States, NMFS said. Pollock block imports from the Republic of Korea could also decrease because of restrictions by the United States and by the Soviet Union on fishing within their 200-mile zones.

Tight supplies of finfish in relation to the anticipated quantity demanded will likely cause prices to rise. However, price increases could be limited by buyer resistance and by competition from relatively lower priced meat and poultry products.

Larger supplies, along with increased consumption, characterized the market for finfish products. Cod fillet sales posted a 34 percent gain above a year ago, while sticks and portions increased 14 percent. Production of sticks and portions rose 3 percent and 15 percent, respectively, prompting imports of blocks to increase 21 percent, a record level.

Fillet supplies increased slightly, led by a 30 percent gain in cod imports and 20 percent gains in both flounder and haddock imports. Increased supplies of salmon were the result of a 64 percent increase in domestic production. Species that experienced lower supplies during 1976 included ocean perch, turbot, and halibut.

Although the total per capita consumption for canned fish was unchanged, salmon and sardine sales were above 1975 levels, while consumption of canned tuna declined slightly.

Cod, Haddock, Yellowtail Flounder Rules Released

Final regulations governing the catch of cod, haddock, and yellowtail flounder by domestic fishermen have been published by the National Marine Fisheries Service. They do not apply to foreign fishermen who are forbidden to retain any of the three species they might catch.

These are the first set of final regulations to be published by the Service implementing a fishery management plan developed by one of the eight Regional Fishery Management Councils. The "Atlantic Groundfish Plan" was developed by the New England Council. The regulations replace emergency regulations implemented last March by Secretary of Commerce Juanita M. Kreps, which expired 12 June.

Under the final regulations now effective, the quota of 10,000 metric tons of yellowtail flounder that may be caught east of 69 degrees west longitude are allocated on a quarterly basis as follows: 1 January through 31 March, 1,500 mt; 1 April through 30 June, 2,500 mt; 1 July through 30 September, 3,500 mt; 1 October through 31

December, 2,500 mt. An additional 4,000 mt may be taken west of 69 degrees as a bycatch when other species are caught.

The quota for cod caught by recreational fishermen has been deleted from the final regulations because of insufficient catch data to establish a quota. In order to obtain this data, all vessels under 100 tons carrying passengers for hire will have to keep logs and record where the fish are caught, the approximate number and weight of cod and haddock caught daily, and the number of persons fishing.

Fishermen may not keep any haddock less than 16 inches long, except that 10 percent of the weight of the total catch by commercial fishermen may be undersized fish, and recreational fishermen may keep a maximum of two undersized haddock or cod per angler each trip. United States fishing vessels catching any of the species must have proper size identifying markings in a manner described in the regulations. The changes in the final regulations are the result of recommendations of the New England Fishery Management Council following a study of the emergency regulations.

First 1977 Porpoise Mortality Reported

An estimated 4,654 porpoises were killed 14 March through 9 June incidental to yellowfin tuna purse seine fishing in the eastern tropical Pacific Ocean, according to the National Oceanic and Atmospheric Administration's National Marine Fisheries Service. The average number of porpoise killed each time the nets were set was 4.4 per set. An average of 0.39 were killed for each ton of yellowfin tuna caught by the U.S. tuna purse seine fleet.

The total allowable 1977 mortality under present regulations is 59,050. Estimates of porpoise deaths are based on radio reports from NMFS observers assigned to 34 U.S. tuna purse seiners. The Commerce Department agency will make adjustments in later reports for any mortality that may have occurred during 1 January through 13 March 1977, when some porpoise-associated fishing took place under court order.

A general permit for taking marine mammals incidental to yellowfin tuna purse seine fishing operations was issued 15 April by the NMFS to the American Tunaboat Association, San Diego, Calif., on behalf of all U.S. yellowfin tuna fishermen. The allowable mortality of no more than 59,050 porpoises is a 24 percent reduction from the 1976 quota of 78,000.

Since 14 March, yellowfin tuna fishermen have been allowed to fish on porpoise under a court order that permitted them to kill up to 9,972 porpoises until a new permit was issued. However, they were prohibited from taking any whitebelly and eastern spinner porpoise. Under the 1977 permit, they are permitted to kill up to 7,840 whitebelly but the prohibition on eastern spinner remains.

By species and stock, the total allowable 1977 kill and the estimated kill during the period 14 March-9 June are as follows:

Species or stock	1977 total	Est. kill
Spotted dolphin (offshore)	43,090	3,105
Spinner (whitebelly)	7,840	1,178
Common (northern)	400	0
Common (central)	1,600	0
Common (southern)	5,600	280
Striped (northern)	40	0
Striped (northern equatorial)	400	86
Other dolphin (includes bottlenose, rough-toothed, Fraser's, and Risso's dolphins, and short-finned pilot whales)	80	5

A clarification of regulations for tuna fishing on porpoise now permits fishermen to continue a set on porpoise even if eastern spinner, a depleted species, is identified after the set is begun.

Under the Marine Mammal Protection Act of 1972, the fishermen would be subject to penalties as a result of such unintentional taking. Under the clarification, when the tunaboat captain is satisfied that a school does not contain eastern spinner, he may begin his set. Should eastern spinner be sighted later and accidentally encircled or killed in the course of completing the set, this will not be cause for issuance of a notice of violation, provided all other procedures required by regulation have been followed.

Oil Impact on Puget Sound Organisms Eyed

Contracts totaling nearly $150,000 have been awarded by the National Oceanic and Atmospheric Administration (NOAA) to make baseline studies of marine organisms which might be affected by pollution resulting from petroleum transportation and refining activities in the Puget Sound region. The awards went to the University of Washington in Seattle, the University of Alberta in Edmonton, Alberta, Canada, and Western Washington State College at Bellingham from the Commerce Department agency's Environmental Research Laboratories of Boulder, Colo. Huxley College of Environmental Studies at Western Washington State received $43,086, the College of Fisheries' Research Institute at the University of Washington, $54,600, and the Department of Microbiology at the University of Alberta, $49,992.

The contracts are part of an intensive study of the Strait of Juan de Fuca and northern Puget Sound to determine the probable impact of increasing oil shipment and refining activities there. The study is funded by the U.S. Environmental Protection Agency, and managed by NOAA's Marine Ecosystems Analysis Puget Sound program office.

Western Washington State College will study the types of sea-floor dwelling organisms which inhabit the tidal areas along the west coast of Whidbey Island, Wash., between Deception Pass and Admiralty Head. This information will be added to similar data gathered previously in northern Puget Sound, San Juan Islands, and the Strait of Juan de Fuca. Results of these studies will form a comprehensive picture of sea-floor marine communities in the region.

Scientists at the University of Washington will analyze how oil pollutants may be consumed by marine organisms and transferred to other aquatic populations and to human consumers. The research will concentrate

on four sites where existing oil refineries are located or oil transfer facilities are proposed: Cherry Point near Ferndale; March Point near Anacortes; Burrows Bay; and Port Angeles, Wash.

In a related study, the University of Alberta will research the microbial breakdown of petroleum in the Puget Sound region. Results of the study will provide baseline information on microbial action on crude oil, specifically Prudhoe Bay crude oil from Alaska, in the Strait of Juan de Fuca and northern Puget Sound.

New FCMA Foreign Fishing Fees Proposed

A schedule of fees to be paid by foreign vessels and foreign nations fishing within 200 nautical miles of the U.S. coasts has been proposed for 1978 by the National Oceanic and Atmospheric Administration, a Commerce Department agency. Such fees are required by the Fishery Conservation and Management Act (FCMA) of 1976 that extended U.S. fisheries jurisdiction to the 200 nautical mile limit on 1 March, 1977.

The only change from the 1977 schedule is the use of updated fish prices as the basis for calculating the poundage fee proposed for 1978. In most cases, the proposed poundage fees would be computed on the basis of 1976 average ex-vessel prices contained in "Fisheries of the United States."

The average ex-vessel (dockside) value per metric ton follows for each species: butterfish, $622; Pacific cod, $282; tanner crab, $441; Pacific flounders (except halibut), $387; Pacific hake, $32; red hake, $185; silver hake, $184; Atlantic herring $87; Pacific herring, $344; Atlantic mackerel, $259; Jack mackerel, $110; other Atlantic fin fish, $334; Pacific rockfish, $298; and sablefish, $399.

Prices will be based on foreign countries of the following species not landed in the United States; pelagic armorheads; atka mackerel; other Pacific ground fish; Alaska pollock; and snails (meats).

Prices for Atlantic squid, $414, and for Pacific squid, $55, are based on raw data used to develop the value for squid in "Fisheries of the United States".

More than $10 million dollars have been paid this year to the U.S. General Treasury by foreign nations for fishing within the 200-mile limit off U.S. coasts. Assuming that the projected number of foreign vessels are permitted to fish, and that allocations are eventually realized, revenues from the fees in 1977 are expected to amount to $10.4 million from the poundage fees based on the ex-vessel value of the fish taken, $1.4 million from the vessel permit fees, and $750,000 from observer fees for a total of $12.5 million.

The proposed schedule provides that each foreign fishing vessel will be charged permit fees of $1.00 per gross registered ton; 50 cents per gross registered ton for vessels which only process fish; and $200 per vessel for support vessels which neither catch nor process fish. Moreover, each foreign nation with fishing vessels in the zone will be charged a fee of 3.5 percent of the total ex-vessel value of fish allocated to the nation.

Hearings Consider Joint Ventures Between United States and Foreign Firms

A series of public meetings has been conducted to obtain comments on the possibility of American-caught fish being sold to foreign processing vessels within the 200-mile fishery conservation zone, the National Marine Fisheries Service (NMFS) reports. The Commerce Department agency is concerned that such arrangements might cause overfishing of certain stocks by U.S. fishermen and disrupt the management system provided under the Act.

Several requests have been received by NMFS, a part of the National Oceanic and Atmospheric Administration, to use foreign processing vessels to process fish caught by U.S. fishermen. Some of those foreign processing vessels are owned by joint U.S.-foreign interests. Moreover, some of those vessels hold permits that entitle them to operate in the U.S. fishery conservation zone, and some do not. Other inquiries contemplate U.S. fishermen catching and selling certain species of fish in an amount that could result in the total domestic and foreign catch exceeding the optimum yields established by preliminary management plans.

At present, foreign processing vessels with permits to operate within the zone are not restricted as to whose fish they may process as long as they comply with the provisions of the permits.

"Under the Fishery Conservation and Management Act of 1976, we must first protect the resource, make sure U.S. fishermen and the U.S. fishing industry have the first chance at using the resource, and then make any surplus available to foreign fishermen," said Robert W. Schoning, Director of NMFS.

"We need nationwide input into this important policy decision to be sure that we do not take any premature action that may have to be reversed and in the process hurt the resource and the U.S. fishing industry," said Schoning. "Waiting until the Regional Fishery Management Councils and others have had a chance to study the situation will not cause serious harm to the resources, U.S. industry, or foreign interests."

Discussions at the meetings have centered upon transactions at sea between foreign support vessels and U.S. fishing vessels. Possible courses of action identified by NMFS include such actions as modifying existing preliminary management plans and regulations in 1977; changing the optimum yield statement with or without new biological, social, or economic data; adjusting existing foreign allocations; modifying existing permits and issuing new ones; establishing a long-range policy for United States and foreign joint participation in fishing ventures under both preliminary and fishery management plans; and taking other related steps. The Service intends to publish a rulemaking procedure concerning modification of permits.

NOAA, USGS Publish New Coastal Zone Maps

A series of 11 coastal zone maps of U.S. areas showing both the topography of the land and the bathymetry of the ocean and other water areas will be published jointly in the next 15 months by the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Geological Survey, the two agencies have announced. The series includes maps of the Houston and Bay City (Tex.) quadrangles; the Savannah and Brunswick (Ga.) quadrangles; and the Los Angeles, Monterey, Santa Ana, San Diego, Long Beach, Eureka, and Smith River (Calif.) quadrangles.

Effective administration of a variety of coastal zone activities, including Federal OCS oil and gas leasing and development, near-shore and onshore oil and gas programs administered by states, Federal water pollution activities, and the new Coastal Energy Impact Program require maps that accurately delineate the land and ocean bottom characteristics, according to officials of NOAA's National Ocean Survey. NOAA is a Commerce Department agency.

The multicolor maps, commonly called "topo-bathy maps," are designed for use mainly by coastal zone planners and administrators as well as for conservationists, environmentalists, and others interested in programs, projects, and activities in coastal wetlands, on the Outer Continental Shelf (OCS), and in other coastal areas.

Robert H. Lyddan, chief of the Geological Survey's Topographic Division, USGS National Center, Reston, Va., and R. Adm. Allen L. Powell, director of NOS, Rockville, Md., said the new multipurpose maps represent a marriage of the USGS land topographic information and the NOS bathymetry (topography of the ocean bottom) into a single product, meeting many different needs for a variety of users, where presently several different maps are being used.

The USGS and NOS already have published two 1:250,000 scale (1 inch represents 4 miles) topo-bathy maps in the series, each covering about 8,000 square miles (20,100 square km). The first was an experimental version of part of the coastal zone of North Carolina, published in 1975 and identified as the Beaufort Quadrangle. It has elevation contour line intervals of 25 feet on land, 2 m in water to the 200-m depth, and 10 m in water over 200 m deep.

The second map covers part of the lower New Jersey coast and includes parts of Delaware, Delaware Bay, and the Delaware River as far up as Philadelphia. Identified as the Wilmington (Delaware) Quadrangle, the map was published in two versions: one in the standard format and the other overprinted with the Bureau of Land Management's OCS lease blocks.

More than 100 of the 1:250,000-scale maps would be required to cover the entire coastal zone of the conterminous states and about 85 such maps would be needed for the coasts of Alaska and Hawaii. The two Federal officials said production of larger scale maps at 1:24,000 (1 inch represents 2,000 feet) and 1:100,000 (1 inch represents 1.6 miles) also are underway for areas along the coast of Georgia.

Copies of the Beaufort and Wilmington maps may be purchased, prepaid, for $2 each, from the Branch of Distribution, U.S. Geological Survey, 1200 South Eads Street, Arlington, VA 22202, with checks or money orders payable to the U.S. Geological Survey; or from the National Ocean Survey, Distribution Division C44, 6501 Lafayette Avenue, Riverdale, MD 20840, with checks or money orders payable to NOS, Department of Commerce. The Beaufort map is identified as Map NI 18-4 and the standard format Wilmington map is identified as Map NJ 18-2. The Wilmington map overprinted with the BLM lease blocks, identified as Map NJ 18-2 OCS, is available only from the NOS.

OCEANLAB FACILITY PROPOSALS SOUGHT

The National Oceanic and Atmospheric Administration (NOAA) requested proposals earlier this year for a contract to conduct studies leading to development of "Oceanlab," planned to be the world's most advanced mobile underwater laboratory.

Oceanlab will be a national facility for underwater science and engineering, supporting research on living and nonliving resources, on the development of offshore energy sources, and on obtaining information for marine environmental and resource management. Providing knowledge to help develop and verify safety standards and requirements for undersea operations and diver safety and effectiveness will also be an important part of Oceanlab's mission.

The proposed system would include two components: 1) a mobile undersea facility to operate as a manned engineering and science laboratory, capable of working at depths to either 300 or 1,000 feet (91.5 or 305 meters). The depth capability selected will depend upon relative costs and other trade-offs; and 2) a lockout minisub that can extend the research depth to 2,000 feet (609.5 m), with diver lockout to 1,500 feet (457 m). Mission performance requirements, system configuration, and technical specifications and designs developed under the contract will contribute to the development of construction proposals.

The successful bidder will not be prohibited from providing or constructing any of the systems or major components, or from acting as subcontractor or consultant to the supplier, NOAA officials said.

The concept for Oceanlab was drawn up within the Commerce Department agency's Office of Ocean Engineering by its Manned Underseas Science and Technology office. It followed extensive consultations with government, academic, and industrial research organizations, commercial firms with underwater expertise, and the recreational diving community. No new hardware developmental work will be under-

taken, as the technology already exists for construction of undersea craft with comparable depth capabilities.

In concept—final design details may vary considerably—Oceanlab will be about 125 feet (38 m) in length, with about a 20-foot (6-m) beam, and 450-600 tons displacement. In addition to a small crew it will have a scientific diver capacity of about nine, some of whom can be maintained at one atmosphere (surface pressure). The others can be pressurized to depth for out-of-laboratory research excursions.

Oceanlab's range will be approximately 1,000 nautical miles (1,853 km) on the surface, and 50 to 100 nautical miles (92.5 to 185 km) submerged, with a total 30-day duration. All operations will be independent of surface support.

The companion "lockout-minisub" will be carried piggy-back, and will operate with the larger vehicle. It is conceived at present as a vehicle of about 35 feet (10.7 m) in length, with capacity for about six persons; two vehicle operators at one atmosphere, and up to four divers who can operate from a pressurized compartment. It will have a submerged range of 20 to 30 nautical miles (37 to 55.5 km) and a top speed of about 3 knots.

Fishermen's Protective Act Vessel Fees Listed

The National Marine Fisheries Service has announced fees to be paid by U.S. fishing vessel owners to protect them against losses if their vessels are seized by foreign countries. The rates are in effect 1 July through 30 September 1977, according to the Commerce Department agency.

Under the Fishermen's Protective Act, NMFS uses the fees to help pay costs to owners whose vessels are sized under jurisdictional claims not recognized by the United States. When a vessel is seized the owners are paid for confiscation of fish, vessel, or gear; any damage incurred to the vessel; other costs such as fuel, food, and port fees while they are seized; and up to 50 percent of lost fishing time.

The rate schedule calls for a flat fee of $60 on each vessel, plus an added fee of 45 cents per ton on vessels of less than 500 gross tons, and 62½ cents per ton on vessels of more than 500 gross tons.

Although the rates are the same as last year's, the skippers will be charged only one-third as much because the fee period is only one-third as long, ending with the expiration of the Act on 30 September. Following this period, if no seizures occur, the fees will be refunded, provided the Fishermen's Protective Act is not extended. If the Act is extended, the money will be applied against fees for the following year, ending 30 September 1978.

Since the beginning of the program, approximately $1.5 million in fees have been collected and an additional $2.5 million have been appropriated. Approximately $3 million have been paid in claims resulting from seizures by Peru, Ecuador, and Panama of U.S. vessels off their coasts.

BLUEFIN TUNA RULES OKAYED

Regulations to help conserve the supply of Atlantic bluefin tuna—a favorite of both commercial and recreational fishermen—were adopted in June by the National Marine Fisheries Service. They took effect immediately, the Commerce Department agency announced. The regulations apply to catches off the east coast of the United States during 1977, and change some of the rules that were in effect last year.

Under the new regulations all recreational and commercial fishermen who fish for bluefin weighing more than 300 pounds must obtain a certificate from the NMFS Regional Director in Gloucester, Mass. In addition, purse seine fishermen catching bluefin weighing from 14 to 115 pounds must also obtain such a certificate. Purse seine fishermen could not catch bluefin weighing more than 300 pounds until September 1. NMFS is part of the National Oceanic and Atmospheric Administration.

For tuna weighing between 115 and 300 pounds, a special 25-ton quota has been established to obtain scientific data and for tagging purposes. Tuna weighing more than 300 pounds cannot be caught and released unless they have been tagged with NMFS tags.

Vessel certificates issued for 1977 will be valid until returned to the Regional Director or until the vessel leaves the fishery. If ownership of the vessel changes, the new owner must obtain a new certificate for that vessel.

Additional detailed regulations apply only to purse seiners and restrict their net size to 4.5 inches in the main body or 8 inches in the selvedge; they may not have a thread count of less than 24 anywhere in the net; and nets cannot exceed 2,700 feet overall. Purse seine vessels and gear must be inspected by an NMFS agent prior to fishing at the beginning of the season, and purse seine fishermen must make daily reports of their catches to NMFS.

The regulations were issued under the authority of the Atlantic Tunas Convention Act of 1975, which ratified U.S. participation in the International Commission for Conservation of Atlantic Tunas. The Commission is responsible for the study of the populations of tunas and tuna-like fishes in the Atlantic Ocean, and recommends conservation proposals for joint action by member governments to maintain stocks at high levels. Member countries of the Commission are Brazil, Canada, Cuba, France, Ghana, Ivory Coast, Japan, Korea, Morocco, Portugal, Senegal, South Africa, Spain, and the United States.

Copies of the complete 1977 regulations may be obtained from the Director, National Marine Fisheries Service, NOAA, Washington, DC 20235, or the Director, Northeast Region, NMFS, NOAA, 14 Elm Street, Gloucester, MA 01930.

Marine Species Checked for Anti-Cancer Drugs

A team of scientists at the University of Oklahoma—almost 500 miles from the nearest salt water—is collecting marine animals from as far away as the Caribbean and Bermuda to determine if

they contain substances that could prove helpful in the fight against cancer and heart disease.

The project, which received a $100,000 Sea Grant from the National Oceanic and Atmospheric Administration last summer, has been supported by the Commerce Department agency since 1971. During that time, the Oklahoma researchers have extracted more than 200 chemical compounds which have shown promise in experiments with laboratory animals either as anticancer agents or as substances that are active on the central nervous system or the heart and circulatory system.

Professors L.S. Ciereszko, F.J. Schmitz, and P.N. Kaul and their students skin dive to collect their specimens from tropical coral reefs of the Bahamas, Jamaica, Florida, and Bermuda. The Oklahoma team first derives crude extracts from the specimens. After any positive action of the extracts has been confirmed, they are subjected to chemical study to isolate the pure compounds that have potential usefulness as drugs. The structure of these compounds is then determined.

Larger quantities of the compounds are then obtained—by harvesting the animals they came from or by synthesizing them in the laboratory—and referred to interested pharmaceutical companies for preclinical and clinical studies required before a new drug can be introduced.

Marine organisms of the greatest interest to the Oklahoma scientists include corals, sea whips, sea fans, anemones, and other animals low on the evolutionary ladder. The group is also studying certain sponges because their extracts lower blood pressure and improve the tone of the heart muscle. Natural and synthetic chemical compounds with these properties are potentially useful in treating hypertension and heart disease.

Although the search for these drugs from the sea starts with animals found in nature, it is unlikely that they will be the ultimate source of any useful drugs that may be discovered. According to the University of Oklahoma scientists, after the structures of the compounds are known, it will generally be cheaper to produce commercial quantities in the laboratory by synthesizing the drugs than by obtaining them from natural marine resources.

Introduction of a new drug into clinical use normally requires 7 to 10 years after its initial discovery. In the case of natural drugs, the preclinical development alone—detection, isolation, identification, evaluation, and toxicological studies—may require 5-10 years.

Marine, Atmospheric Institute Initiated

A cooperative institute linking the University of Miami and the Environmental Research Laboratories of the National Oceanic and Atmospheric Administration (NOAA) has been established within the oceanographic complex on Virginia Key in Miami, Fla. Henry King Stanford, President of the University of Miami, made the announcement with Robert M. White, NOAA Administrator, in early summer.

The Cooperative Institute for Marine and Atmospheric Studies, called CIMAS, is intended to serve as a focal point for concentrated research on specific scientific problems of the ocean and atmosphere by specialists from the parent organizations. From time to time, scientists from elsewhere in Florida, the nation, or the world will be named visiting fellows at CIMAS to augment the expertise of the Miami oceanographic laboratories.

As a first assignment, CIMAS will consider oceanic influences on the earth's climate over periods of seasons, years, and decades. Such climatic fluctuations are not well understood by scientists, but can have significant economic and political consequences.

The founding fellows of CIMAS will be Eric B. Kraus and Claes G. Rooth of the University of Miami's Rosenstiel School of Marine and Atmospheric Science, and Ants Leetmaa of the Commerce Department agency's Atlantic Oceanographic and Meteorological Laboratories.

Kraus will serve as director of the fledgling organizations. A noted specialist in air-sea interaction, he was director of the NATO Advanced Study Institute on Modelling and Prediction of the Upper Layers of the Ocean, and has been chairman of the Rosenstiel School's division of atmospheric science for many years. Rooth, who has been chairman of the School's division of physical oceanography, has worked in recent years on the rate at which the oceans transport heat to high latitudes, and the dynamics of this climatically important process. Leetmaa, a physical oceanographer, has had an active part in POLYMODE, an international experiment to study mesoscale ocean variability.

Environmental Satellites Launched for NOAA Studies

A new environmental monitoring satellite, positioned to keep watch over the eastern half of the United States and the Atlantic Ocean, was launched 15 June, in time for this year's hurricane season. The satellite, GOES-2, is the latest in a series of Geostationary Operational Environmental Satellites to be operated by the National Oceanic and Atmospheric Administraion (NOAA). It was placed into an earth synchronous orbit at an altitude of about 22,300 miles (35,800 km) with a velocity which will keep it in position over the equator above South America.

From that position, instruments aboard the satellite will let it "see" the development of hurricanes in the tropical Atlantic or Caribbean, and follow any storm's movement. The satellite routinely transmits imagery back to earth every half hour, day and night; more frequently when necessary. GOES-2 is expected to replace an earlier spacecraft of the same series in maintaining the east coast and Gulf watch. Another satellite of the series is positioned above the equator over the Pacific Ocean, watching the western half of the United States and the Pacific as far west as Hawaii.

Originally conceived as weather satellites, the geostationary spacecraft do provide a host of data of importance

to weather forecasters. They use both visual and infrared imagery for severe storm evaluation and to analyze cloud cover, winds, ocean currents, fog distribution, storm circulation, snow melt, and other environmental phenomena.

But other instruments on board enable the satellite to receive and transmit to earth information from data collection platforms on land and in the oceans; such information as water levels in rivers and reservoirs, ocean wave heights, rain and snowfall measurements, and the like. Additionally, from digital data provided by the satellite, scientists are able to determine wind speeds and directions and cloud heights. Instruments also monitor solar "storms" by measuring X-rays and high energy particles emitted by the sun.

Since May 1974, when the first spacecraft of the series was launched, the use of data has rapidly expanded until today the information is used by such divergent interests as marine shipping companies, forestry officials, and commercial fishermen.

Infrared radiometers provide Atlantic Coast and Gulf of Mexico shipping with precise information on the locations of the Gulf Stream and the Gulf Loop Current, enabling ships to utilize or avoid the current in those waters. Gulf fishermen also use the information to find productive fishing grounds.

Both the Coast Guard and Civil Air Patrol use geostationary satellite data in their search and rescue efforts, and current research projects indicate imagery and digital data provided by the spacecraft may be of use to agricultural interests by showing freeze lines, soil moisture content, and the like.

The GOES-2 satellite will be used as part of a planned international research project expected to improve forecast accuracy, increase the length of time over which forecasts can be made, and improve the understanding of the physical processes that affect climate and climatic change.

Known as the first Global Experiment of GARP (Global Atmospheric Research Program), the effort eventually will include similar spacecraft from Europe, Japan, and the Soviet Union.

Manufactured by Ford Aerospace and Communications Corporation, as were the first three spacecraft in the series, GOES-2 is expected to replace GOES-1 as the eastern satellite for NOAA at about 75° west longitude. The earlier spacecraft will be moved to about 105°W on stand-by basis, according to present plans.

Although weighing 1,385 pounds at launch, the GOES-2 satellite was reduced in weight to 647 pounds in orbit, after the fuel in its apogee boost motor—which positions the spacecraft into final orbit—was expended. It is drum-shaped, about 75 inches (190 cm) in diameter, and 11 feet (3.4 m) long.

The satellite's orbit and altitude are matched with the earth's rotation so the spacecraft is placed into what appears to be a stable position above the same spot on earth.

MISSIONS AND SUBSYSTEMS

The GOES-2 satellite carried five basic subsystems aloft to accomplish a variety of missions, including:

1) Providing near-continual, high-resolution visual and infrared imaging over large areas of North and South America and surrounding oceans at least every 30 minutes;

2) Collecting environmental data from up to 10,000 remote observing platforms on land, in the ocean, and in the air;

3) Measuring energetic solar particle flux, X-rays, and the strength of the earth's magnetic field; and,

4) Broadcasting centrally prepared weather and satellite information.

The spacecraft on-board subsystems include:

1) Visible and Infrared Spin Scan Radiometer (VISSR) providing visible and infrared imagery;

2) Space Environment Monitor (SEM) subsystem, including a magnetometer, a solar X-ray telescope, and an energetic particle monitor, all for solar observations;

3) Data Collection System (DCS) providing communications relay between data collection platforms and the Command and Data Acquisition (CDA) Station at Wallops, Va.;

4) Wideband Communication subsystem for transmission of wideband video data, "stretched" VISSR data, and weather facsimile data; and,

5) Telemetry, Tracking, and Command subsystem for commanding the spacecraft and transmitting SEM data.

DELTA LAUNCH VEHICLE

The 116-foot, three-stage Delta launch vehicle used by NASA to launch GOES-2 is built by the McDonnell Douglas Corporation and launched by a combined NASA-McDonnell Douglas team. There have been more NASA Delta launches than all other vehicles in its class combined, and the GOES-2 launch will be the 131st using the Delta vehicle.

The first stage produces 205,000 pounds thrust at sea level. Nine solid propellant boosters, each producing 52,000 pounds, are attached to the base of the first stage. Six fire at lift-off, and the final three ignite when the first six burn out. Delta-131 will weigh about 293,000 pounds (132,900 kg) at liftoff. Separation of the first stage comes about 4 minutes into the flight.

The second stage, providing 9,800 pounds thrust in a vacuum, will be fired first immediately after the first stage separation, burning for about 5 minutes, and again about 12 minutes after liftoff for about 10 seconds. About 1 minute later, the second stage will separate, followed by ignition of the third stage of the vehicle which utilizes a solid propellant motor producing about 14,000 pounds thrust. It separates from the spacecraft about 25 minutes into flight, when the satellite is almost 6,000 miles (9,654 km) downrange and moving at about 22,000 miles (35,398 km) per hour, at an altitude of about 135 miles (217 km).

This velocity places the spacecraft in a transfer orbit from which it is positioned into a circular orbit at about 22,300 miles (35,800 km) altitude above the Equator by a motor aboard the spacecraft, with a final velocity of about 6,876 miles (11,066 km) an hour.

ICELANDIC GROUNDFISH PROSPECTS TOLD

The Government of Iceland is reviewing its groundfish industry to develop measures to preserve demersal stocks and stabilize this important segment of the national economy. Demersal fish are species dwelling near the ocean floor, such as cod, haddock, saithe, redfish (ocean perch), and others and have been the main sources of supply for Iceland's export-oriented fishing industry for years.

A recent study by the Directorate of Fisheries underlines trends in foreign and Icelandic groundfish catches from 1971-76 (see table).

Foreign and Icelandic groundfish catches in Iceland's waters, 1971-76.

	Catch in metric tons						Percent change
	1971	1972	1973	1974	1975	1976	1971-76
Foreign	390	314	279	253	197	152	−61.0
Icelandic	417	377	390	408	430	437	+ 4.8
Total	807	691	669	661	627	589	−25.7

The table reveals two dominant trends. First, the foreign groundfish catch has been declining steadily while the Icelandic catch has been increasing irregularly and by modest quantities. In 1971, foreign trawlers caught almost as many groundfish as native fishermen, but by 1976 the Icelandic groundfish catch was about three times larger than that of foreign vessels. Second, the total demersal catch from Icelandic waters declined steadily over the 5-year period, and by 1976 it was 218,000 t less than in 1971, a decrease of 25.7 percent. The decline in foreign fishing for groundfish will continue through 1977. With British trawlers no longer fishing in Iceland's economic zone, the foreign groundfish catch will probably be about half as large as it was in 1976.

On the other hand, Iceland's 1977 groundfish catch is more difficult to estimate. During the first quarter of 1977, groundfish landings totaled 141,000 t, a considerable increase over the 113,000 t landed during the corresponding period in 1976. The cod catch alone increased to 95,000 t for the first 3 months of 1977 from 82,000 t for 1976. Icelandic groundfish landings for the remainder of the year will depend, however, on how far the Government is willing to go to establish and enforce catch quotas for the overfished groundfish stocks.

The Ministry of Fisheries will emphasize fishery conservation as a major policy goal. Fisheries Minister Matthias Bjarnason stated that the 1977 total cod catch should not exceed 275,000 t and asked the leaders of the Icelandic Cutter Owners' Organization to comply with the Government's cod allocation program. Under the Government's plan, 260,000 t of the total cod allocation would be reserved for Icelandic fishermen; the rest would be allocated (as specified in bilateral agreements) to the Faroe Islands, Belgium, West Germany, and Norway. (The foreign allocation breakdown is: Faroe Islands 8,000 t; West Germany, 5,000 t; Belgium, 1,500 t; Norway, 500 t.) When Icelandic fishermen have caught 240,000 t of cod, the remaining 20,000 t of their quota will be divided among all the vessels on a per trip basis. The Cutter Owners' Organization has apparently accepted the plan, agreeing that drastic measures had to be taken to permit the recovery of the cod stocks, especially in the waters off the northwest coast of Iceland.

From 1971 to 1976 Iceland's cod catch has varied from a low of almost 230,000 t in 1972 to a high of 282,000 t in 1976. A cod quota of 260,000 t for Icelandic vessels would, if enforced, result in a loss of more than 20,000 t of the most valuable of all groundfish species landed in Iceland. As the table indicates, Iceland's total groundfish catch has not increased a great deal since 1971, and there is little hope that the cod trawlers will be able to compensate for decreased cod catches by increasing significantly their catch of other groundfish. According to Icelandic sources, any increase in the 1977 fisheries catch will probably result from higher catches of pelagic species, such as capelin and the underexploited Norway pout (Source: IFR-77/109.)

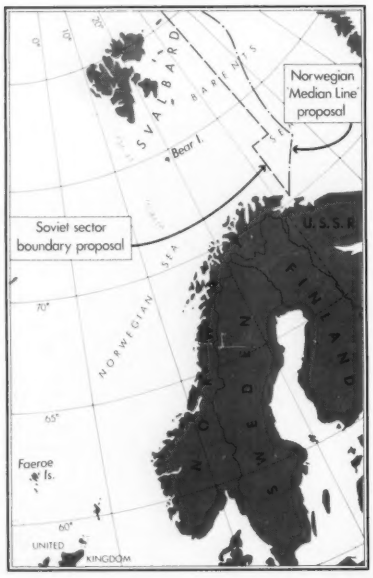
Norway's International Fishery Agreements Noted

The Government of Norway concluded a number of agreements on fishing by foreign countries within Norway's new 200-mile fishery zone by mid-1977. Negotiations with the Soviet Union on the delimitation of the respective fishing zones in the Barents Sea were continuing.

The NMFS International Fisheries Analysis Branch has followed these negotiations closely. Although some of the agreements were incomplete and certain details on the accords had not been released, the Branch has prepared this report on the status of foreign fishing inside Norway's 200-mile zone. The report's three parts describe the talks with: 1) the European Economic Community countries (EEC), 2) non-EEC countries (Spain, Portugal, and the Faroe Islands), and 3) Communist countries (the Soviet Union, East Germany, and Poland).

EUROPEAN ECONOMIC COMMUNITY COUNTRIES

Fishery relations between Norway and the EEC countries have generally been good; many problems, however, held up the conclusion of negotiations until an agreement on catch quotas was finally made. Prominent among the problems were Norway's insistence on reducing substantially the fishing activities of all foreign countries by the



Norwegian and Soviet proposals for fishing limits in the Barents Sea.

end of 1980, and the Norwegian unwillingness to give up full jurisdiction over fishery resources inside its 200-mile zone by submitting disputes to independent arbitrators. In addition, Norway claimed that fishery stocks in its zone were being depleted faster than fishery resources in the EEC zone and demanded a reduction of EEC fishing which has increased rapidly in recent years (especially by West German fishermen).

Norway has also sought to define "balanced reciprocal fishing" in the two zones by proposing that quotas be "weighted" to allow for the value as well as the quantity of fish caught in EEC and Norwegian waters. Such a formula would be beneficial to the Norwegians since a large share of their catch in EEC waters consists of relatively low-value fish used for reduction, while most of the EEC catch in the Norwegian zone is higher-valued cod and other groundfish species. Finally, Norway has insisted on the right to continue fishing up to 12 miles of the United Kingdom coastline, while the British fishing industry is engaged in a campaign to win EEC approval for an exclusive 50-mile fishing zone.

Norway and the EEC arrived at a partial agreement on fishing quotas in their respective zones. Details on Norwegian fishing rights in the EEC's 200-mile zone are not available at this writing, and, significantly, Norway granted an overall fishing quota to the Community rather than breaking it down among the different EEC member-states which have traditionally fished in Norwegian-claimed waters. The 1977 EEC catch allocations represent an overall reduction of about 33 percent from 1976. The details are: 1) For Arctic cod, the EEC allocation is 36,300 t for the 1 January-31 August 1977 period. (The EEC cod fishery in Norway's zone is limited to the waters north of lat. 62°N and represents a 25 percent reduction from the 1976 NEAFC allocation.); 2) The saithe (or Atlantic pollock) EEC allocation is 25,000 t for all of 1977; 3) The quota for the Greenland halibut fishery, conducted exclusively around Bear Island, is 700 t for 1 January-31 August; 4) Norway has prohibited directed fisheries for haddock. The haddock by-catch may not exceed 13.3 percent of the cod catch; 5) For redfish (ocean perch), North of lat. 62°N and west of long. 20°E, EEC countries can catch 7,500 t of redfish in 1977.

The EEC countries may continue to fish all other species at the 1976 catch levels. Catches taken before the agreement went into effect will be deducted from the total 1977 allocation. According to British reports, for example, there will be no fishing for redfish since the 7,500 t quota had already been taken when the agreement was made. The agreement became Norwegian law on 20 May 1977.

SPAIN, PORTUGAL, AND THE FAEROE ISLANDS

Spain and Portugal, which are relative newcomers to the Arctic cod fishery in Norway's waters, had to accept the sharpest reductions in their fishing quotas. Both countries will be permitted to fish only north of lat. 62°N and only beyond 50 miles of the Norwegian coast. The catch allocations are as follows.

For Spain, the Arctic cod fishery in the Norwegian zone has been reduced from an actual 1976 catch of about 7,000 t to a 1977 quota of 3,000 t. No directed haddock fishery is permitted, and only 400 t of haddock may be caught as a by-catch in the cod fishery. The saithe and redfish quotas are 4,100 t and 2,500 t, respectively. The total 1977 allocation is 10,000 t.

Portugal's Arctic cod quota is 2,800 t, and the haddock quota, permitted only as a by-catch in the cod fishery, is 375 t. The saithe and redfish allocations are both 1,000 t and the total is 5,175 t.

Norway and the Faeroe Islands agreed previously on 1977 fishing quotas in their respective zones. The Faeorese fishermen are permitted a catch of 10,000 t of demersal (groundfish) species in the Norwegian zone north of lat. 62°N of which 7,500 t can be Arctic cod. In return, the Norwegians can take 10,000 t of demersal fish inside the Faeroese 200-mile zone. Faeroese fishermen will, in addition, be permitted to catch 15,000 t of mackerel in the North Sea sector of the Norwegian 200-mile zone, while their sand eel, great weaver, and sprat fisheries will remain at 1976 levels. About 15-20 Norwegian fishing vessels will be allowed to fish for hake in Faeroese waters.

SOVIET UNION, EAST GERMANY, AND POLAND

Both East Germany and Poland have agreed to reduce their 1977 fisheries catch in Norwegian waters by about 25-30 percent below the NEAFC quotas for 1976. On the other hand, Norway has allowed some increase in the East German and Polish catches in the waters around the Svalbard Islands. East German and Polish fishing vessels will be permitted to operate up to 12 miles off the Norwegian coast until the end of 1979, and in the zone between 50 and 200 miles until the end of 1981. Beginning in 1982 they will have to fish outside Norway's 200-mile zone. Following are East German, Polish, and Soviet allocations in the Norwegian zone for 1977.

For East Germany, an Arctic cod catch of 3,000 t will be permitted north of lat. 62°N. The haddock catch will be restricted to a 400 t by-catch in the cod

fishery. The saithe quota is 12,500 t and the allocation for blue whiting is 2,000 t. In the sector of the Norwegian zone north of lat. 62°N and west of long. 20°E, the East German quotas are 18,000 t of redfish, 3,000 t of saithe in the directed fishery, and 600 t of saithe as a by-catch; the total allowed is 39,500 t.

Poland is permitted an Arctic cod catch of 1,400 t north of lat. 62°N. The haddock catch will be restricted to 185 t as a by-catch in the cod fishery. The saithe quota is 2,200 t and the allocation for blue whiting is 2,000 t. North of lat. 62°N and west of long. 20°E, Polish fishermen may catch 3,200 t of redfish, south of lat. 62°N, the Poles may catch 10,000 t of saithe and 1,500 t of other demersal fish as a by-catch in the saithe fishery. Norway has also granted the Poles 500 t of mackerel and other pelagic fish south of lat. 62°N. The total catch will be 20,985 t.

Fishery negotiations between the Soviet Union and Norway have been delayed and prolonged by a number of issues which are not directly related to fishing, such as the nature of Norwegian adminsitrative rights in the Svalbard Islands, naval-strategic questions, and disagreements over future access to offshore energy resources in the Barents Sea. The fishery talks have dealt primarily with the delimitation of fishery zones in the Barents Sea (see map). On 25 May, the Soviet Union put into force a 200-mile zone in the Barents Sea, and the Government of Norway declared a 200-mile zone around the Svalbard Islands on 3 June, to become effective on 15 June. The mutual extensions of zones have not, however, solved the problem of agreeing on a line of demarcation. The current talks probably have better prospects of producing an accord on the so-called "grey zone" where Soviet and Norwegian claims overlap.

As far as fishing quotas are concerned, the major issue in the Barents Sea is the division of the Arctic cod allocation. Norway and the Soviet Union have already agreed on an overall cod quota in the Barents Sea of 810,000 t, the same as in 1976. Norway and the Soviet Union will each take 330,000 t, plus 40,000 t of so-called coastal cod, while the remaining 150,000 t will be divided up among foreign countries with fishing rights in the Norwegian and Soviet zones. Common management of the Barents Sea Arctic cod is necessary because the stock spawns in the Norwegian zone, migrates and spends adolescence in Soviet waters, and finally returns as fully grown fish to the Norwegian zone. An excessive cod fishery in either of the two zones would, therefore, ultimately result in declining cod catches in the other. (Source: IFR-77/123.)

Norway Wants to Boost Shellfish Cultivation

Norway is giving more consideration to the rich shellfish life which abounds along her coasts, according to the Norwegian Information Service. A recent international survey shows that a small country such as Holland has a yearly production of 158,000 tons of mussels while Norway with its long coastline, 250,000 islands, bays, and rocks only produces 30,000 kg. Indifference and lack of information appear to be the primary reasons why mussels, etc., are so little eaten in Norway, not to mention being cultivated.

Many countries in Europe have a thriving shellfish cultivation industry, not least in Denmark, Ireland, Holland, and France. Norway, with its long coastline, has the natural resources to be able to produce at least 10 times the crop which Holland now produces, reports Norinform.

Present Norwegian production reveals not only a major disparity between Norway and her European neighbors but a tremendous indifference so far as utilization of natural resources and potentialies are concerned. Intensified cultivation in Norway would mean an increase in international food production, assist Norwegian self-sufficiency, and create new jobs. There are many coastal communities who would welcome more jobs in a new and non-polluting industry.

Without question, shellfish represent good and nourishing food with a high protein, vitamin, and mineral content. Norwegian conditions are just right for shellfish cultivation with its plankton-rich and pollution-free waters.

To rectify the present situation, the Norwegian Government has given financial support to a film on shellfish cultivation in Norway in the hope that it will stimulate interest in the utilization of the vast latent resources along the country's lengthy coastline.

Spain Seeks Bilateral Pacts, Joint Ventures

Spain has been conducting a series of bilateral fishery negotiations and establishing joint ventures with countries in whose waters it has traditionally fished, and which recently extended their fishery jurisdictions. Fishing agreements have been signed with the United States, Canada, the European Community (EC), Norway, Mauritania, and Morocco.

Despite these agreements, the Spanish distant-water fleet is likely to be severely hampered by the new fishing restrictions accompanying the extensions of fishery zones. Although Spanish distant-water fishery landings totaled only 17 percent of the 1.5 million metric tons (t) landed in 1975, they accounted for 29 percent of the total value of such landings, which was US$106 million. Within the Spanish fishing fleet, which is the third largest in the world, the distant-water fleet has been the most rapidly expanding, but its future has now become uncertain. Important species caught by the distant-water fleet are cod, hake, tuna, and cephalopods.

Under the bilateral agreements already concluded, Spain will receive less fish than it has traditionally caught inside 200 miles of foreign coasts. The Spanish-United States agreement, for example, will reduce the 1977 Spanish catch to 14,400 t from the 20,700 t allocated in 1976. The main species

which the Spanish vessels will be allowed to catch are 9,300 t of long- (*Loligo*) and short-finned (*Illex*) squid, and 1,500 t of butterfish; the remaining 3,600 t are other finfish.

The 2-year agreement with Canada will also substantially reduce the Spanish catch. In 1977, Spain will be permitted to catch only 29,400 t of cod, compared to the 90,000 t allocated in 1976.

Due to its probably entry into the EC, Spain was not treated as a "third country" during the EC-Spanish negotiations. Consequently, Spain will not be phased out of Community waters like the East European countries (German Democratic Republic, Poland, and the Soviet Union) and may receive an allocation based on the average catch taken from EC waters in the past.

Under the terms of the Spanish-Norwegian agreement, Spain's distant-water fleet will be permitted to fish in Norwegian waters until 1980. Cod allocations, however, will not surpass 7,000 t per year.

West African waters, particularly on the Saharan Bank, have been important grounds for the Spanish fishing industry. The Saharan Bank is a coastal shelf where North Atlantic, Mediterranean, and equatorial currents converge to form an area rich in marine life. Spanish vessels have traditionally fished this area for cuttlefish, hake, octopus, sardine, squid, and tuna. Conflicts have arisen, however, with Morocco and Mauritania which recently extended their fishing zones to 70 and 150 miles, respectively.

Despite these difficulties, Spain has concluded agreements with both countries. The Moroccan agreement will allow Spain to catch only 50,000 t of fish per year, although the agreement will remain in force for 5 years. The terms of the Mauritanian agreement, however, are much harsher. A maximum tax of US$200 per gross registered ton will be imposed on Spanish vessels, while no more than 290 vessels will be allowed to operate in Mauritanian waters. In addition, Spanish vessels must land at least 25,000 t of fish annually in the port of Nouadhibou and sell it to Mauritanian companies at local prices. The Spanish government is currently trying to revise this agreement to obtain better terms.

To ensure a continued supply of fish, particularly hake and tuna, Spanish officials have begun negotiations to obtain fishing rights in Latin America. Fishing agreements have recently been signed with Chile and Costa Rica, and negotiations will soon be concluded with Venezuela and Argentina.

In addition, Spanish companies have organized a series of joint fishery ventures with Argentina, Ireland, Libya, Morocco, and Mauritania. As these joint ventures are generally subject to fewer restrictions than bilateral agreements, Spanish processors are hopeful that the supply of fish to their plants will be maintained. For instance, the Argentine joint venture is expected to provide 40,000 t of fish annually to the Spanish market.

Despite the fishery agreements concluded with Canada, the EC, and Norway, as well as the joint fishery ventures, Spain is unlikely to obtain adequate supplies of fish, particularly of cod. Consequently, the Spanish distant-water fleet is threatened with obsolescence and will probably be converted to medium-water operations in the near future. In addition to crippling the distant-water fleet, Spain's loss of its traditional fishing grounds has also had political repercussions. Growing criticism of Spanish fishery policy has resulted in the resignation of the Director-General for Fisheries, D. Victor Moro, who has been replaced by Felix Gragado Mayol. (Source: IFR-77/102.)

Bay of Fundy Herring Fishery Value Rising

Canada's Bay of Fundy herring fishery by purse seiners in 1977 should reach more than double its value of 2 years ago, Roméo LeBlanc, Minister of Fisheries and the Environment, has predicted. Federal initiatives will also increase the value of the weir and gillnet fisheries, he said.

Conversion of the purse-seine fishery from animal meal to higher-value food production forms part of a new $1.4 million program involving improved ice facilities, close planning of catches to match market capacity, and several other measures. Led in development by Fisheries and Marine Service officials

Fernand J. Doucet (Special Adviser to the Minister), T. Derrick Iles, and Peter M. Jangaard, the new program is a major step in the rehabilitation of the entire Bay of Fundy herring fishery.

The conversion begun last year in the purse-seine fishery for large herring already raised the value of its 1976 landings over 1975 from $2.8 million to $4 million, for 20,000 tons less fish caught. The proportion of landings used for food went from 20 percent to 66 percent, the average price went from about $33 to $66 per metric ton, and the fishing and shore-worker season lasted 2 months longer. In 1977, shore employment should double again over 1976 and landed value of the fish should reach $7 million, strengthening the economy on both sides of the Bay of Fundy, LeBlanc said.

"We managed this change-over through intensive consultations with fishermen, who in turn organized themselves to help run this fishery better," LeBlanc said. "I have preached organization to fishermen, I have preached consultation to my officials, and this shows what we can gain: more money, and a better working partnership between fishermen, processors, and government."

The key to increasing the purse-seine fishery's value was a system of individual boat quotas. In previous years, fishermen raced each other to catch the biggest share of the overall herring quota. The large catches far exceeded the daily capacity of the developing food industry and went mainly into fish meal, a low-price and low-employment use of herring.

"We had a fleet of expert fishermen fishing each other to death," LeBlanc said. "The season would start in mid-June and they'd catch up the quota by mid-August. To make matters worse, fish meal demand fluctuates markedly. A 1975 drop in price forced us to pay a $750,000 subsidy to keep the fleet going. At that point, we started a major effort to make the fishery work better."

With government support, the purse-seine fishermen formed a marketing cooperative, now including 90 percent of the purse-seine fleet. The cooperative and Fisheries and Marine Service officials worked out individual boat quotas, guaranteeing each boat a share of the catch to take at a slower rate. Weekly catch limits improved the match of catching to processing rates. Enforcement of existing regulations restricted fish meal production. Canadian processors increased their efforts in food processing, some with assistance from the federal Department of Regional Economic Expansion, so that nearly double the 1975 tonnage of large herring went into food in 1976.

Processing of large herring for food will again increase in 1977. Bay of Fundy plants expect to increase capacity from 30,000 metric tons (t) to 50,000 t, eastern Nova Scotia and northern New Brunswick plants will truck in an estimated 5,000 t, and Polish transport and processing vessels will buy some 15,000 t from Canadian seiners. The Minister of Fisheries and the Environment permitted the fishermen's cooperative to negotiate the Polish contract because Canadian processing capacity remained insufficient for the 72,000-t herring quota. In addition, the Polish company has contracted to buy processed herring from Canadian companies.

Prices to Canadian fishermen and processors for Bay of Fundy herring should rise in 1977. Extension of coastal-state jurisdiction and depleted herring stocks have created shortages in many herring markets. As a result, the demand for Canadian herring is expected to exceed available supplies of food quality herring in 1977. In addition, world prices for fish meal and oil, which remain by-products of the Bay of Fundy herring fishery, have risen substantially over the past year.

New aspects in 1977 of the federal program for the Bay of Fundy herring fishery are:

1) Authorized expenditure of up to $750,000 over 2 years to provide ice-making facilities ashore; additional assistance to convert vessels to carry ice and bring in better-quality fish to the plants; investigation of future aid for installation of cold storage facilities.

2) Development of an up-to-the-moment information system to enable constant matching of catch rates to processing capacity.

3) Increased effort in herring and mackerel fishing by large seiners in the Gulf of Maine and on George's Bank, to take available quotas and divert fishing pressure from the near-shore fishery.

4) Research studies related to food herring production by processing plants and fishermen's cooperatives.

5) Work on a catch insurance scheme for the herring weir fishery, to compensate for extreme catch variations in this fixed-gear fishery mainly for juvenile "sardine" herring; also, planned assistance for weir fishermen to build pounds to hold fish live until markets open, and special attention to marketing problems in the weir fishery in New Brunswick and Nova Scotia.

6) Development studies on a herring-roe fishery with special reference to the gillnet fleet, and measures to link this fleet into the overall information and management system for herring marketing, plus examination of other means of improving the gillnet fishery.

7) New arrangements to avoid over-catches of herring that result in dumping.

"I congratulate the fishermen, processors, and my own officials who have transformed the Bay of Fundy purse-seine fishery," Mr. LeBlanc said. "When I met with the fishermen several times last year, I warned them we were taking a risk together. We met some obstacles; we could meet more. But so far, we have made the fish yield better value, we are changing an unreliable fishery to a reliable one, and we have seen a fisherman's organization emerge that should be able to stand on its own feet."

Japan, Russia Sign New Fish Agreement

Japan and the Soviet Union signed a new bilateral fisheries agreement in Moscow on 26 May 1977. The new agreement sets the rules for Japanese fishing in the Soviet 200-mile fishery

zone which became effective on 1 March 1977. Japan caught 1.4 million metric tons (t) of fish and shellfish in this zone in 1975.

In the new agreement, Japan recognized Soviet sovereignty over fishery resources inside the Soviet zone. From now on, the Soviet Union will issue permits and charge permit fees for Japanese fishing in this zone. Soviet inspectors will board Japanese fishing vessels to insure that they have permits on board and keep detailed logs of their catches. Every 10 days the Japanese catch data must be communicated to Soviet authorities.

The Soviet Union and Japan agreed on a quota of 62,000 t for the 1977 Japanese highseas salmon fishery. No salmon may be caught inside the new Soviet fishery zone. For more details on the agreement, request IFR-77/99 from any NMFS Statistics and Market News office.

Sweden and Russia Discuss Baltic Fishing

The Government of Sweden is attempting to conclude negotiations with the Soviet Union and other neighboring states on fishing limits in the Baltic Sea. The Soviet Fisheries Minister arrived in Stockholm on 13 May 1977, immediately after the conclusion of bilateral fishery negotiations with Japan, and was to stay in Sweden for 1 week. The Swedish Minister of Agriculture and fishery officials scheduled talks with the Russian official from 31 May to 2 June. Immediately after, on 3 and 4 June, the Parliament (Riksdag) began to debate the Government's bill to extend Sweden's Baltic fishing limit according to the median-line principle.

Within the Government of Sweden there has been a debate over the best means of proceeding toward the extension of fishery limits. Prime Minister Falldin's cabinet has sought from the beginning the broadest possible domestic support to counter expected foreign opposition. For this reason, the Swedish government carefully discussed the zonal proposal with the Soviet Union and submitted a bill to the Parliament which only asked for authorization to extend the Swedish Baltic fishing limits sometime in the future rather than requesting that a bill be passed to extend the fishing limits immediately. This approach met with opposition from the Social Democrats who favor an immediate extension of Swedish jurisdiction in the Baltic, perhaps even without negotiations with the other Baltic states. A meeting of the Foreign Relations Council of the Riksdag on 24 May failed to resolve this issue, and the Foreign Minister's later statements made evident that the Government was still unsure about the timing and the details of the move. There was reason to believe that the Swedes would not actually declare the extended fishing limits until they held consultations, not only with the Soviet Union, but also with Denmark, Poland, Finland, and East Germany.

The original Baltic fishing limits proposal was submitted to the Swedish Parliament in early 1977[1]. Using the island of Gotland as the baseline, it would give about 45 percent of the Baltic to Sweden. The Soviet Union, on the other hand, has consistently maintained that, if Baltic zones are to be drawn, Sweden must use the Swedish mainland as its base-line instead of Gotland. Following the Soviet proposal, the line of demarcation between the Soviet and Swedish Baltic fishing zones would run just east of Gotland. The significance of the claim to economic rights in the area around Gotland is heightened by the fact that, in addition to fishing, there are reportedly sizeable oil and natural gas deposits near Gotland. According to the Swedish press, the Soviet Fisheries Minister raised the issue of exploitation of energy resources in his June talks with the Swedes.

According to the NMFS Branch of International Fisheries Analysis, the Swedish move represents an effort to prop up a sagging fishing industry by asserting jurisdiction over a large Baltic zone and shifting the emphasis from long-distance Atlantic trawling to the inshore and medium-distance Baltic fishing.

At present barely 10 percent of the Baltic fishery catch is made by Swedish vessels. In addition, over the past dozen years Sweden's fisheries catch decreased by almost one-half. Between 1964 and 1976, the annual catch declined from 387,000 t to just under 200,000 t, and most of the decrease was due to the virtual collapse of Sweden's North Sea herring fishery.

Sweden's decision, however cautiously taken, to solve the fisheries question through the Baltic zone has caused a protracted diplomatic conflict with the Soviet Union and Denmark. The Soviets and the Danes not only disagree with Sweden over jurisdiction in the waters around Gotland and Bornholm Islands, but they also dispute Sweden's right to establish a large fishing zone in a basically inland sea in which five different countries have significant fishing operations. Consequently, the Soviet Union has insisted, with Danish support, that the Baltic fisheries dispute be resolved through agreements on fishing quotas rather than through the introduction of zones.

The Swedes are in a strong position on this question, however, since both the Soviet Union and Denmark, have recently extended their fishery jurisdictions. Also, as far as the disagreement over how to draw the baseline is concerned, the Swedes can claim that using the eastern coast of Gotland as the baseline is justified since the Soviet Union recently made the same claim for the islands north of Hokkaido in their fishery negotiations with Japan. The thrust of the Swedish bargaining position is that their proposal is not a radical departure from, but a logical extension of, international trends.

The final bill authorizing the government to extend the Swedish fisheries jurisdiction was submitted to the Riksdag on 28 March. The first round of negotiations with the USSR followed on 18 April and continued for 5 days

[1] See "Sweden to extend its Baltic Fishing Zone." Mar. Fish. Rev. 39(5): 38-39.

without producing an agreement. Since the Soviet Union had recently arrived at an interim fisheries accord with Japan, there was some reason to believe that it would make greater efforts to resolve European fisheries matters by negotiation with Sweden, Norway, and the European Economic Community.

Japanese Whale Meat Imports Rise in 1976

Japan, the world's largest consumer of whale products, imports large quantities of whale meat, which substitutes for other forms of meat in the Japanese diet. Japan balances these imports with exports of domestically produced whale oil.

Japan's whale meat imports increased by almost 13 percent in 1976, from 28,800 metric tons (t) to 32,400 t (Table 1). The value of these imports, however, rose almost 48 percent from $19.7 million in 1975 to $29.2 million in 1976. Imports from the Soviet Union in 1976 were about 70 percent of the total whale meat imports, while imports from Iceland amounted to about 10 percent.

Whale oil exports declined significantly in 1976 when a total of 12,170 t, valued at about $5 million, was exported, or 48 percent by quantity and 26 percent by value less than in 1975. Almost all whale oil is exported to the Netherlands; only small quantities were exported to the Republic of Korea, Taiwan, and a few other countries (Table 2).

The NMFS International Fisheries Analysis Branch has recently prepared a report on the Japanese whaling industry. The report describes Japan's catch and utilization of whales, including sections on production, trade, consumption, processing, and the structure of the industry. If interested in obtaining a copy, please request IFR 77-105 from: International Fisheries Analysis Branch, F411, National Marine Fisheries Service, NOAA, U.S. Department of Commerce, Washington, DC 20235.

Table 1.—Japanese imports of fresh, chilled, or frozen whale meat, 1975-76.

Country	Quantity (t)		Value (US$1,000)	
	1976	1975	1976	1975
Brazil	48	115	53	107
Chile	88	6	50	3
Iceland	3,703	2,269	4,052	2,530
Korea, North	38	158	23	61
Korea, Rep. of	1,195	612	2,292	1,182
Peru	1,492	1,989	1,060	1,056
Somalia	1,478	1,510	2,162	1,667
South Africa	207	313	272	251
Soviet Union	22,853	21,293	18,387	12,362
Spain	1,374	556	826	456
Total	32,476	28,821	29,177	19,675

Source: Japan Marine Products Importers Association. "Imports of Marine Products by Country," 1975 and 1976.

Table 2.—Quantity (in metric tons) and value (in US$1,000) of Japanese whale oil exports, 1975-76.

Country	Quantity		Value	
	1976	1975	1976	1975
Nonbaleen oil				
India	2	1	3	1
Iraq	10	—	5	—
Korea, Rep. of	215	168	102	91
Netherlands	2,932	9,856	1,824	2,864
Philippines	1	23	1	16
Salvador	5	15	4	12
Taiwan	194	108	122	67
Thailand	6	5	5	4
Total	3,365	10,176	2,066	3,055
Baleen oil				
Korea, Rep. of	1	—	—[1]	—
Netherlands	8,793	13,146	2,815	3,563
Philippines	10	—	6	—
Taiwan	1	—	3	—
Total	8,805	13,146	2,824	3,563
Grand total	12,170	23,322	4,890	6,618

[1]Less than $500.
Source: Japanese Ministry of Finance, "Exports and Imports: Commodity by Country," and "Exports and Imports: Country by Commodity," published by the Japan Tariff Association.

EEC Extends Ban on Herring Fishing

Meeting in Brussels, Belgium, the Agriculture Ministers of the European Economic Community (EEC) decided on 16 May to extend the regulation of the herring fishery in the North Sea and in the waters off the western coast of Scotland. The decision was a temporary measure and was taken after a marathon session lasting into the morning hours.

The compromise extended the current (31 May 1977) ban against fishing for herring in the North Sea and off western Scotland until the end of June. The only exception was that the Netherlands was permitted to catch up to 1,500 metric tons (t) of herring in the North Sea for its "Maatjes" festival.

The European Commission had originally proposed to the EEC Agriculture Ministers that the ban against North Sea herring fishing be extended until 31 December 1977, and that catch quotas be determined for the herring fishery off Scotland, in which the United Kingdom would receive the largest share.

Only the United Kingdom supported the Commission's proposal for a ban until the end of 1977. The Irish supported the Commission on the North Sea ban, but not for the waters off Scotland. The remaining member states preferred small quotas for both areas. The Agriculture Ministers also suggested that the special council of the Fishery Ministers scheduled for 27 June to discuss the EEC's internal fisheries regime should reexamine the question of herring conservation. (Source: U.S. EEC Mission, Brussels, IFR-77/94.)

According to the NMFS Office of International Fisheries, proposals for conserving the depleted herring stocks have been a major bone of contention within the EEC and the Northeast Atlantic Fisheries Commission (NEAFC). The chief difficulty is the large Danish fish reduction industry which requires, among other species, steady supplies of herring and sprat to keep the reduction plants active throughout the year. The Danish reduction fishery has developed in the last 10 years and, as recently as 1973, Denmark caught almost 400,000 t of herring in the northeast Atlantic (including the North Sea). Despite the ban against directed fishing for herring in the North Sea, the Danes are still catching some because they are allowed a 10 percent herring by-catch in their North Sea sprat fishery. Unconfirmed reports indicate that, because of the difficulty of monitoring by-catches precisely, the Danish North Sea herring by-catch is actually considerably higher than 10 percent of the sprat catch.

Scientific studies clearly reveal the need for a total herring fishing ban in the North Sea. According to a recent report submitted to the EEC Commission, the North Sea herring stock will be depleted in 5 years unless the fishery is closed to permit stocks to recover. The herring breeding stock is estimated to have declined to about 10 percent of the minimum scientists feel is necessary for the stock to maintain itself. As

early as 1971, an OECD study by Norwegian marine biologists concluded that the herring stocks in the northeast Atlantic had declined from an estimated 14 million t in 1955 to less than 1 million 5 in 1970.

Nonetheless, the herring catch in the northeast Atlantic, although declining, continues to be significant. Between 1970 and 1975 catches decreased from about 1.5 million t to a little more than 1 million t, and the total allowable North Sea herring catch for the June 1974-July 1975 season was 488,000 tons. In 1976, the North Sea herring quota was set at 160,000 t and Denmark's share, by far the largest, was 43,000 t.

In recent EEC discussions, the European Commission and the United Kingdom have stood most consistently for a permanent ban against the herring fishery, and Denmark has found itself increasingly isolated on this issue. The Federal Republic of Germany and the Netherlands, both importing large quantities of herring, have been reluctant to oppose the Danish point of view. It appears that, either as a result of a permanent ban imposed this summer, or through repeated extensions of temporary bans, the North Sea herring fishery may be closed for the remainder of 1977.

FRENCH FISH IMPORTS INCREASE IN 1976

French imports of fishery products continued to increase during 1976. Preliminary statistics indicate that 317,756 metric tons (t) of fishery products were imported worth US$560 million (Table 1). This represents a 2.5 percent increase over 1975 figures, when 309,800 t were imported at a value of US$447 million. French fisheries exports in 1976 were 103,784 t worth $140 million. This resulted in a trade deficit of $420 million for 1976.

Principal French fishery imports were cod, herring, mackerel, sardines, and shrimp (Table 2). Salmon imports declined 18 percent compared to 1975, even though the French are supplied with salmon entirely by imports. U.S. salmon exports to France accounted for 83 percent of the total U.S. fishery exports to France in 1976 and were valued at $29.4 million, an increase of almost $7 million since 1975. U.S. fishery exports to France in 1976 totaled 8,241 t and were valued at $33.5 million (Table 3). U.S. imports of French fishery products during 1976 were minimal and consisted mainly of skipjack and yellowfin tuna (Table 4).

There has always been a tendency in France to import highly priced species such as salmon and sole. This is due not only to the relatively high income levels of the French consumer but also to their culinary habits which have favored expensive fish. U.S. fish exporters have yet to take full advantage of the French market; U.S. exports of fishery products represent only 6 percent of the total value of French fishery imports. Species which U.S. exporters might more effectively market in France would include herring, squid, and various shellfish.

Table 1.—French trade balance of fishery products, by quantity and value, 1976.

Product	Quantity (t)			Value (million US$)		
	Imports	Exports	Balance	Imports	Exports	Balance
Fish						
Fresh and frozen	167,438	81,162	−86,276	251	79	−172
Salted, dried, and smoked	15,158	3,747	−11,411	25	9	− 16
Canned	47,239	3,305	−43,934	89	8	− 81
Total	229,835	88,214	−141,621	365	96	−269
Shellfish						
Fresh, frozen, salted, dried, and smoked	73,601	13,459	−60,142	143	31	−112
Canned	14,320	2,111	−12,209	52	13	− 39
Total	87,921	15,570	−72,351	195	44	−151
Grand total	317,756	103,784	−213,972	560	140	−420

Source: *La Pêche Maritime.*

Table 2.—French imports of principal species in metric tons, 1975-76.

Species	Quantity (t)	
	1976	1975
Fish, fresh		
Anchovy	1,608	845
Blackfish	1,054	1,756
Cod	22,440	21,972
Cod fillets	3,552	3,142
Herring	5,004	7,755
Mackerel	11,202	10,058
Sardine	9,148	8,662
Sole	5,343	5,991
Whiting	2,155	2,622
Fish, frozen		
Anchovy	195	90
Blackfish fillets	2,179	2,337
Cod fillets	5,864	5,249
Haddock	175	398
Herring	5,319	5,338
Mackerel	5,172	7,954
Salmon	11,186	13,693
Sardine	16,206	14,368
Fish, cured or salted		
Anchovy	3,369	1,548
Cod, salted	4,029	3,455
Cod, dried	3,584	2,752
Herring	2,809	3,125
Shellfish		
Lobster	718	694
Spiny lobster	1,884	1,911
Grey shrimp[1]	4,152	2,987
Other shrimp	11,242	9,926
Squid	4,746	5,357

[1]Given in French as "crevette grise."
Source: *La Pêche Maritime.*

Table 3.—U.S. fishery product exports to France by principal species, 1976.

Species	Quantity (t)	Value (US$)
Fresh, frozen		
Cod, cusk, haddock, hake, pollock	190	327,342
Salmon	6,396	27,368,351
Salmon fillets	433	1,983,508
King crab	32	229,313
Shellfish	310	494,754
Total, fresh and frozen	7,361	30,403,268
Canned		
Salmon	67	268,260
Shrimp	55	60,453
Total, canned	122	328,713
Grand total	7,483	30,731,981

Source: United States Census Bureau, "U.S. Exports, 1976."

Table 4.—U.S. fishery product imports by principal species from France, 1976.

Species	Quantity (t)	Value (US$)
Fresh, frozen		
Cod blocks	307	443,958
Cusk, haddock, hake, pollock	36	41,968
Skipjack tuna	9,793	3,547,586
Yellowfin tuna	812	454,855
Rock lobster tails	96	1,187,607
Total	11,044	5,675,974

Source: National Marine Fisheries Service, "Foreign Trade (Imports), 1976."

NMFS Scientific Reports Published

NOAA Technical Report NMFS Circular 402. Moser, H. Geoffrey, Elbert H. Ahlstrom, and Elaine M. Sandknop. **"Guide to the identification of scorpionfish larvae (Family Scorpaenidae) in the eastern Pacific with comparative notes on species of *Sebastes* and *Helicolenus* from other oceans."** April 1977. 71 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

ABSTRACT

Developmental stages of 51 species or forms of scorpionfishes are described and illustrated in this identification guide. Thirty-eight are from the eastern Pacific and represent six of the eight scorpaenid genera known from that region—*Sebastes, Sebastolobus, Scorpaenodes, Scorpaena, Pontinus,* and *Ectreposebastes*. *Sebastes* is the most thoroughly treated; developmental series of six species from the eastern Pacific are described and illustrated; pigment patterns of early larvae of 33 species are given and 23 of these are illustrated. Larval series of three North Atlantic species of *Sebastes* are described and illustrated as is a series of *Sebastes* from off Chile; in addition, the published information on eight northwestern Pacific species is summarized and discussed in relation to the eastern Pacific and Atlantic species. The other genera are represented by one or two species. Since larvae of the eastern Pacific species of *Helicolenus* were not available, a larval series of *H. dactylopterus* from the Atlantic are described for comparative purposes. Larvae of the eighth eastern Pacific scorpaenid genus, *Trachyscorpia,* are unknown.

Two dichotomous keys to the eastern Pacific genera are included, one for the early larval stages up to the initiation of notochord flexion and one for postflexion larvae. In the text, a summary of the literature and definitive characters is followed by the descriptive accounts of the species. Each species account contains a literature summary, description, set of illustrations, and information on distribution and abundance.

South Africa Fishery Leaflet Is Printed

A new Foreign Fisheries Leaflet, 77-4, "Southern Africa's Fishing Industry, 1975-76" has been published by the NMFS Branch of International Fisheries Analysis. The 12-page leaflet contains information on catch, quotas, boat-building trends, processing developments, new vessels, the rock lobster industry, whaling, and other subjects. The report was written by Michael Stuttaford, the editor of the *South African Shipping News and Fishing Industry Review,* and was originally published in the "South African Fishing Industry Handbook and Buyers' Guide, 1976-77." A copy can be requested from: Services Branch, D822, ESIC/NOAA, WSC4, 6009 Executive Blvd., Rockville, MD 20852. Please enclose two self-addressed labels to facilitate mailing.

NOAA Technical Report NMFS SSRF-710. Wing, Bruce L., and Nancy Barr. **"Midwater invertebrates from the southeastern Chukchi Sea: Species and abundance in catches incidental to midwater trawling survey of fishes, September-October 1970."** April 1977. 43 p. For sale by the Superintendent of Documents, U.S. Government Printing office, Washington, DC 20402.

ABSTRACT

Midwater invertebrates were collected in the southeastern Chuckchi Sea. A 1.8-m Isaacs-Kidd midwater trawl was used at 20 stations to collect 81 semiquantitative samples; a 3-m otter trawl was used at one station to collect two qualitative samples. Data tables list the species collected and their numbers, size range, and displacement volumes for the midwater trawl stations and a species list only for the otter trawl station. One hundred three species of invertebrates were identified from the midwater trawl samples, and 33 species were identified from the otter trawl samples. Amphipods were the most diverse group (40 species) and decapod shrimps the next most diverse (14 species). Numbers of species in a sample varied from 4 to 40 (mean 17). After removal of jellyfishes, the most important contributors in numbers and volume to the catches were euphausiids and mysids.

Bulletins Announced By Canadian Fishery Agency

Publication of three new Bulletins of the Fisheries Research Board of Canada have been announced by the Fisheries and Marine Service. They include: **Revision of *Hydrobaenus, Trissocladius, Zalutschia, Paratrissocladius,* and some related genera (Diptera: Chironomidae)**, Bulletin 195; **Taxonomic studies on Chironomidae: *Nanocladius, Pseudochironomus,* and the *Harnischia* complex,** Bulletin 196; and **Female genitalia in Chironomidae and other Nematocera: morphology, phylogenies, keys**, Bulletin 197. All were authored by Ole A. Saether of the Fisheries and Marine Service's Freshwater Institute, Winnipeg, Manitoba.

In addition to the taxonomic revisions, Bulletin 195 presents ecological comments and distribution records and discusses methodology and morphology. Cost is $7.00 in Canada; $8.40 elsewhere. Bulletin 196, which includes keys for imagines, pupae, and larvae of the genus *Nanocladius,* costs $5.00 in Canada and $6.00 elsewhere. Bulletin 197, which presents keys and diagnoses to subfamilies, tribes, genera, and some species of some genera of female Chironomidae, costs $6.00 in Canada and $7.20 elsewhere. The books can be ordered from: Printing and Publishing, Supply and Services Canada, Ottawa, Canada K1A 0S9.

Clam Enhancement, Grouper Aging, and a Redfish Law

. . . .**South Carolina's commercial fishermen had** a "good but not great" year in 1976, according to the Fisheries Statistics Section, South Carolina Wildlife and Marine Resources Department. Total shrimp catch—the state's major commercial fishery—was 8.4 million pounds (heads on), down 5 percent from 1975. The total value was constant at $10.7 million. The crab catch dropped 19 percent to 5.3 million pounds, a $900,000 value. Oyster landings topped 1.2 million pounds of meat (380,000 bushels), up 17 percent from 1975, with the value up 26 percent to $780,000. Finfish landings were up 60 percent to 5.7 million pounds with a value of $1.1 million. . . .

. . . .**An experimental program to enhance littleneck and butter clam** populations on some public beaches in Washington State's Puget Sound has been announced by the Washington Department of Fisheries. A private firm will provide from 50,000 to 200,000 clam seeds from each species. The program will be patterned after similar experiments with manila clams and is limited to beaches where the Department previously did manila clam research. If successful, a great impact on Puget Sound sport and commercial shellfish harvests is foreseen. . . .

. . . .**Alaska's Board of Fisheries has upheld its December 1976 ruling** adopting a 28-inch minimum length for both commercial troll-caught and sport-caught king (chinook) salmon, the Alaska Department of Fish and Game reports. The change became effective 1 June. Another regulation was adopted requiring king crab fishing vessels to be inspected 48 hours before fishing in a nonexclusive registration area and 24 hours before fishing in an exclusive area. New shellfish regulations require that dungeness crab pots have two escape rings at least 4⅜ inches in diameter beginning 1 May 1979. The board also ruled that a shrimp trawl vessel is considered to have ceased fishing when its otter doors or trawl beam are visible at the surface of the water or aboard the vessel. . . .

. . . .**Consumption of grayfish, or dogfish, is being promoted** by University of Rhode Island food science researchers. The scientists are frying it in bite-sized pieces, adding it to chowders, salting it for preservation, and making it into a sausage, and they report agreeable results. Looked down on by Canadian and American fishermen, the grayfish is reportedly used to make fish and chips in Scotland. It has about 15 percent protein and only 400 calories in a large serving and, the URI scientists suggest, could add variety to seafood meals, though they don't intend for it to take the place of more popular species. . . .

. . . .The South Carolina Wildlife and Marine Resources Department is developing **a method to determine the age of large grouper and other commercial fish** species without damaging the market value of the catch. Biologists are using cordless electric drills to bore a hole in the fish's skull underneath the gill cover to remove the otolith without damaging the head, as such fish are usually sold with the head on. Commercial landings of snapper and grouper in South Carolina rose from an annual average of 43,000 pounds during the period of 1970-1974 to more than 450,000 pounds in 1976. They are also a favorite of recreational anglers. . . .

. . . .**California's annual and perplexing die-off of striped bass** spread farther upstream from the Sacramento-San Joaquin Delta this year than ever before, according to the Department of Fish and Game. This year the die-off area extended from Crockett in the Carquinez Straits at the western end of Suisun Bay east to Antioch. In previous years as many as 15,000 stripers have succumbed mysteriously between mid-May and September in that area. Though the causes of death are unknown, studies have pointed to such factors as low dissolved oxygen, presence of hydrogen sulfide, and spawning stress. . . .

. . . .**California has a new law increasing the amount of Pacific mackerel** that can be taken incidentally with other species from 18 to 40 percent by weight the Department of Fish and Game reports. Commercial fishermen complained that the increased incidence of Pacific mackerel schooling with jack mackerel—and the difficulty in determining the species composition of the mackerel schools—was interfering with jack mackerel fishing. The difference between the 18 percent Pacific or blue mackerel formerly permitted and the 40 percent under the new law will count against the fishing industry's 1977-78 harvest quota of 1,500 tons, the department noted. . . .

. . . .**A new Texas law limits the amount of redfish or red drum** which can be taken from Texas waters by sport and commercial fishermen, according to the Parks and Wildlife Department. Major provisions call for a daily bag limit of 10 redfish over 14 inches long and 20 in possession for sport fishermen, and a limit of 200 pounds of redfish per day for commercial fishermen. Sport fishermen may not possess more than two redfish over 35 inches long. The act also sets a 1.4-1.6 million pound quota for redfish for the entire coast per year. . . .

The National Marine Fisheries Service (NMFS) does not approve, recommend or endorse any proprietary product or proprietary material mentioned in this publication. No reference shall be made to NMFS, or to this publication furnished by NMFS, in any advertising or sales promotion which would indicate or imply that NMFS approves, recommends or endorses any proprietary product or proprietary material mentioned herein, or which has as its purpose an intent to cause directly or indirectly the advertised product to be used or purchased because of this NMFS publication.

☆ GPO 796-004

UNITED STATES
DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL MARINE FISHERIES SERVICE
SCIENTIFIC PUBLICATIONS STAFF
ROOM 450
1107 N.E. 45TH ST.
SEATTLE, WA 98105

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF COMMERCE
COM-210

Controlled Circulation Rate

U.S.MAIL

MFR XERDX300XCISSDUE005R 1
XEROX UNIV MICROFILMS
SERIALS DEPT
300 N ZEEB RD
ANN ARBOR MI 48106